13.0 NOISE AND VIBRATION

13.1 INTRODUCTION

This chapter of the Environmental Impact Assessment Report (EIAR) describes the assessment undertaken of the potential noise and vibration impact from the proposed Oweninny Wind Farm Phase 3 development on local residential amenity. The Proposed Development consists of 18 no. wind turbines with an overall top of foundation level to blade tip height of 200 m. A full description of the proposed development is provided in Chapter 3 – *Description of the Proposed Development.*

Noise and vibration impact assessments have been prepared for the operational phase, the construction, and decommissioning phases of the proposed development to the nearest noise - sensitive locations (NSLs). To inform this assessment baseline noise levels have been measured at six representative NSLs surrounding the proposed development site. Noise predictions to the nearest NSLs have been prepared for both the construction and operational phases.

Existing operational, permitted, and proposed wind farm developments with the potential for cumulative impacts were identified and reviewed as part of this assessment. In line with best practice guidance the cumulative impact of these other developments has been included in the operational noise impact assessment. Further details on these other developments are provided in Chapter 2 of this EIAR.

For a glossary of terms used in this chapter please refer to Appendix 13.1.

13.1.1 Statement of Authority

This chapter of the EIAR has been prepared by the following staff of AWN Consulting Ltd:

Dermot Blunnie (Principal Acoustic Consultant) holds a BEng (Hons) in Sound Engineering, MSc in Applied Acoustics and has completed the Institute of Acoustics (IOA) Diploma in Acoustics and Noise Control. He has been working in the field of acoustics since 2008 and is a member of the Institute of Engineers Ireland (MIEI) and the Institute of Acoustics (MIOA). He has extensive knowledge and experience in relation to commissioning noise monitoring and impact assessment of wind farms as well as a detailed knowledge of acoustic standards and proprietary noise modelling software packages. He has commissioned noise surveys and completed noise impact assessments for numerous wind farm projects within Ireland.

Mike Simms (Principal Acoustic Consultant) holds a BE and MEngSc in Mechanical Engineering and is a member of the Institute of Acoustics (MIOA) and of the Institution of Engineering and Technology (MIEI). Mike has worked in the field of acoustics for over 19 years. He has extensive experience in all aspects of environmental surveying, noise modelling and impact assessment for various sectors including, wind energy, industrial, commercial, and residential.

13.1.2 Fundamentals of Acoustics

A sound wave travelling through the air is a regular disturbance of the atmospheric pressure. These pressure fluctuations are detected by the human ear, producing the sensation of hearing. To take account of the enormous range of pressure levels that can be detected by the ear, it is widely accepted that sound levels are measured and expressed using a decibel scale i.e., a logarithmic ratio of sound pressures. These values are expressed as Sound Pressure Levels (SPL) in decibels (dB).

The audible range of sounds expressed in terms of Sound Pressure Levels is 0 dB (for the threshold of hearing) to 120 dB (for the threshold of pain). In general, a subjective impression of doubling of loudness corresponds to a tenfold increase in sound energy which conveniently equates to a 10 dB increase in SPL. It should be noted that a doubling in sound energy (such as may be caused by a doubling of traffic flows) increases the SPL by 3 dB.

The frequency of sound is the rate at which a sound wave oscillates is expressed in Hertz (Hz). The sensitivity of the human ear to different frequencies in the audible range is not uniform. For example, hearing sensitivity decreases markedly as frequency falls below 250 Hz. To rank the SPL of various noise sources, the measured level must be adjusted to give comparatively more weight to the frequencies that are readily detected by the human ear. The 'A-weighting' system defined in the international standard, BS ISO 226:2003 *Acoustics. Normal Equal-loudness Level Contours* has been found to provide the best correlations with human response to perceived loudness. SPLs measured using 'A-weighting' are expressed in terms of dB(A).

An indication of the level of some common sounds on the dB(A) scale is presented in Figure 13.1.

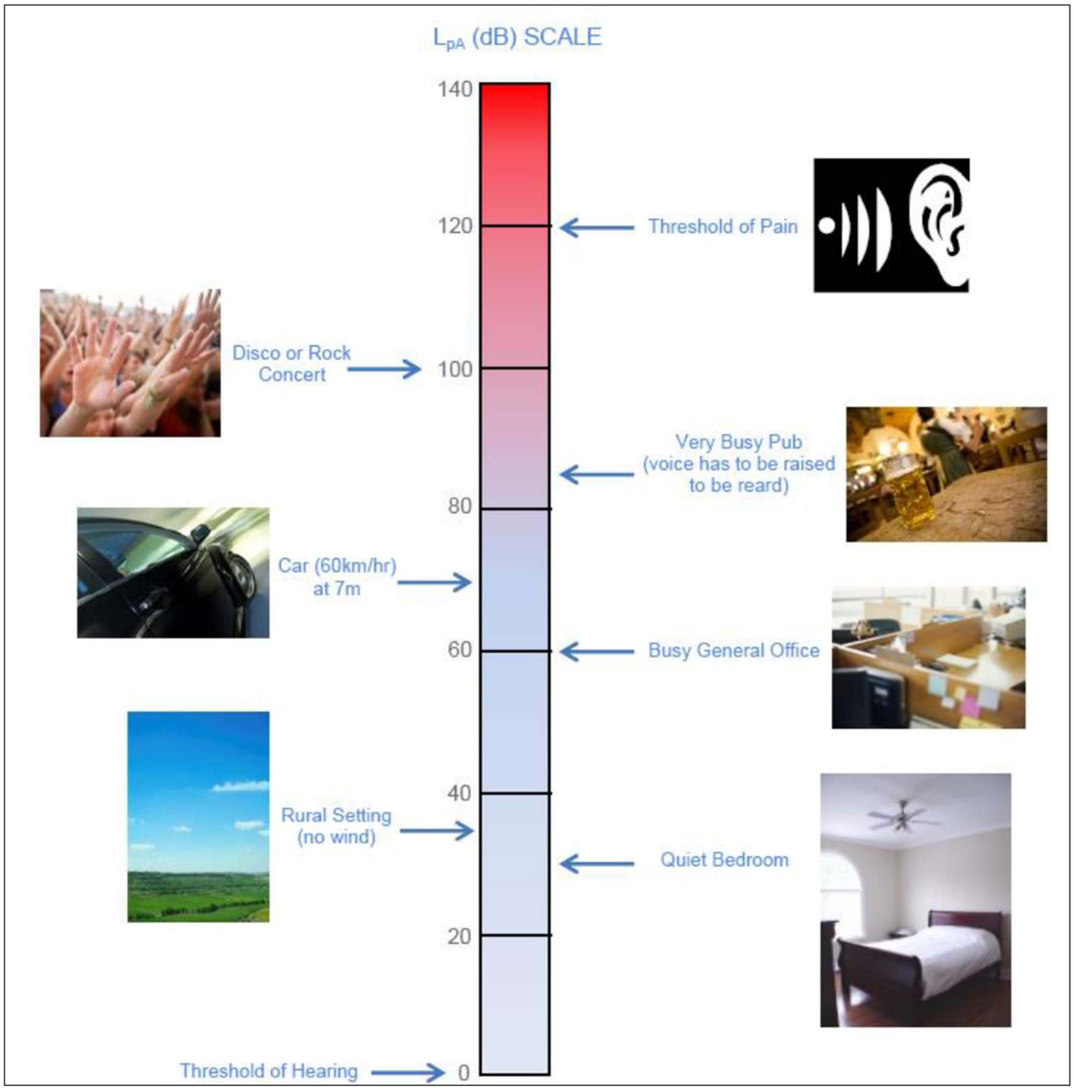

Figure13.1 dB(A) Scale & Indicative Noise Levels – (EPA: Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4 – 2016))

13.2 METHODOLOGY

The assessment of impacts for the proposed development have been undertaken with reference to the most appropriate guidance documents relating to environmental noise and vibration, in addition to specific guidance documents that have been consulted when preparing this chapter of the EIAR:

- EPA Guidelines on the Information to be contained in Environmental Impact Statements, (EPA, 2022).
- Wind Energy Development Guidelines for Planning Authorities, Department of the Environment, Heritage, and Local Government (2006).
- The Assessment and Rating of Noise from Wind Farms, Department of Trade, and Industry (UK) Energy Technology Support Unit (ETSU) (1996).
- A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IOA GPG) (2013).
- Guidelines for the Treatment of Noise and Vibration in National Road Schemes, Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA) (2004).
- British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.
- British Standard BS 5228-2:2009+A1:2014 Code of practice for vibration control on construction and open sites – Vibration.
- BS 7385 – Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration (BSI, 1993).
- United Kingdom Highways Agency (UKHA) Design Manual for Roads and Bridges (DMRB) Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2 (UKHA 2020)
- ISO 1996: 2017: Acoustics – Description, measurement, and assessment of environmental noise.

The assessment methodology undertaken for this assessment is summarised as follows:

- Review of appropriate guidance to identify appropriate noise and vibration criteria for both the construction, operational and decommissioning phases.

- Characterise the receiving environment through baseline noise surveys at various NSLs surrounding the proposed development.
- Undertake predictive calculations to assess the potential impacts associated with the construction phase of the proposed development at NSLs.
- Undertake predictive calculations to assess the potential impacts associated with the operational of the proposed development at NSLs.
- Specify mitigation measures to reduce, where necessary, the identified potential outward impacts relating to noise and vibration from the proposed development.
- Describe the significance of the residual noise and vibration effects associated with the proposed development.

13.2.1 EPA Description of Effects

The significance of effects of the proposed development shall be described in accordance with the EPA guidance document Guidelines on the information to be contained in Environmental Impact Assessment Reports (EIAR), (2022). Details of the methodology for describing the significance of the effects are provided in Chapter 1 – Introduction.

The effects associated with the proposed development are described in the relevant sections of this chapter in accordance with the EPA guidance set out in Chapter 1.

13.2.2 Guidance Documents and Assessment Criteria

The following sections review best practice guidance that is commonly adopted in relation to developments such as the one under consideration here.

13.2.2.1 Construction Phase Noise

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. Local authorities normally control construction activities by imposing limits on the hours of operation and may consider noise limits at their discretion.

In the absence of specific noise limits, appropriate criteria relating to permissible construction noise levels for a development of this scale may be found in the British Standard BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise* (BS5528-1).

The approach adopted here calls for the designation of an NSL into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. A threshold noise value is applied to each category. Exceedances (construction noise only) of the threshold value, at the facade of a noise-sensitive location (NSL) during construction, indicates a potential significant noise impact associated with the construction activities. The threshold values recommended by BS5228-1 are depicted in Table 13-1.

Table 13-1 Example Threshold Potential Significant Effect at Dwellings

Assessment category and threshold value period (T)	Threshold value, in $L_{Aeq,T}$ dB		
	Category A [Note A]	Category B [Note B]	Category C [Note C]
Night-time (23:00 to 07:00hrs)	45	50	55
Evenings and weekends [Note D]	55	60	65
Daytime (07:00 – 19:00hrs) and Saturdays (07:00 – 13:00hrs)	65	70	75

Note A Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.

Note B Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.

Note C Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.

Note D 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

It should be noted that this assessment method is only valid for residential properties. The following method should be followed:

For the appropriate period (e.g., daytime) the ambient noise level is determined and rounded to the nearest 5 dB. At some properties, particularly those located close to busy roads, the ambient noise levels are expected to be relatively high. However, given the rural nature of the site in general, reference has been made to the quietest properties near the development which have daytime ambient noise levels typically in the range of 30 to 55 dB $L_{Aeq.T}$. Therefore, for the purposes of this assessment, as a worst case, all properties will be afforded a Category A designation. See Section 13.4.2 for the detailed assessment in relation to this site. If the specific construction noise level exceeds the appropriate category value (e.g., 65 dB $L_{Aeq,T}$ during daytime periods) then a significant effect is deemed to occur.

13.2.2.2 Construction Phase Vibration

Vibration standards come in two varieties: those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. With respect to this development, the range of relevant criteria used for building protection is expressed in terms of Peak Particle Velocity (PPV) in mm/s.

Guidance relevant to acceptable vibration within buildings is contained in the following documents:

- BS 7385 – Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration (BSI, 1993) (BS7385).
- BS 5228-2:2009+A1:2014 – Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration (BSI, 2014) (BS5228-2).

BS7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15 mm/s at low frequencies rising to 20 mm/s at 15 Hz and 50 mm/s at 40 Hz and above. These guidelines relate to relatively modern buildings and should be reduced to 50% or less for more critical buildings.

BS5228-2 recommends that, for a soundly constructed residential properties and similar structures that are generally in good repair, a threshold for minor or cosmetic (i.e., non-structural) damage should be taken as a peak particle velocity of 15 mm/s for transient vibration at frequencies below 15 Hz and 20 mm/s at frequencies above than 15 Hz. Below these vibration magnitudes minor damage is unlikely, although the standard notes that where there is existing damage these limits may be reduced by up to 50%. In addition, where continuous vibration is such that resonances are excited within structures the limits discussed above may need to be reduced by 50%.

The Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) publication Guidelines for the Treatment of Noise and Vibration in National Road Schemes (NRA, 2004) also contains information on the permissible construction vibration levels during the construction phase as shown in Table 13.2.

Table 13-2 Allowable Vibration at Sensitive Properties (NRA, 2004)

Allowable vibration (in terms of peak particle velocity) at the closest part of sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	**10 to 50Hz**	**50 to 100Hz (and above)**
8 mm/s	12.5 mm/s	20 mm/s

Following review of the guidance documents set out above, the values in

Table *13-2* are considered appropriate for this assessment as they provide more stringent vibration criteria.

13.2.2.3 Additional Vehicular Activity on Public Roads Construction Phase

There are no specific guidelines or limits relating to traffic related sources along the local or surrounding roads. Given that traffic from the development will make use of existing roads already carrying traffic volumes, it is appropriate to assess the calculated increase in traffic noise levels that will arise because of vehicular movements associated with the development.

For the assessment of potential noise impacts from construction related traffic along public roads and it is proposed to adopt guidance from United Kingdom Highways Agency *Design Manual for Roads and Bridges* Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2 (DMRB).

Table 13-3, taken from DMRB offers guidance as to the likely short term impact associated with any change in traffic noise level.

Table 13-3 Likely Impacts Associated with Change in Traffic Noise Level (Source DMRB, 2020).

Change in Sound Level (dB L_{A10})	Magnitude of Impact
0	No change

0.1 – 0.9	Negligible
1 – 2.9	Minor
3 – 4.9	Moderate
≥5	Major

Section 3.19 of DMRB states that construction noise and construction traffic noise shall constitute a significant effect where it is determined that a major or moderate magnitude of impact will occur for a duration exceeding:

- 10 or more days or nights in any 15 consecutive days or nights; or
- A total number of days exceeding 40 in any 6 consecutive months.

The DMRB guidance will be used to assess the predicted increases in traffic levels on public roads associated with the proposed development and comment on the likely short-term impacts during the construction phase.

13.2.2.4 Operational Phase Noise

The noise assessment documented in this chapter is based on guidance in relation to acceptable levels of noise from wind farms as contained in the document *Wind Energy Development Guidelines for Planning Authorities* published by the Department of the Environment, Heritage and Local Government in 2006. These guidelines are in turn based on detailed recommendations set out in the Department of Trade and Industry (UK) Energy Technology Support Unit (ETSU) publication *The Assessment and Rating of Noise from Wind Farms* (1996). The ETSU document has been used to supplement the guidance contained within the "*Wind Energy Development Guidelines*" publication where necessary. Planning permissions and decisions issued by An Bord Pleanála and / or the local authority in relation to wind energy sites in the wider area are also reviewed here.

The Assessment and Rating of Noise from Wind Farms – ETSU-R-97

As stated previously the core of the noise guidance contained within the Wind Energy Development Guidelines is based on the 1996 ETSU publication The Assessment and Rating of Noise from Wind Farms (ETSU-R-97).

ETSU-R-97 calls for the control of wind turbine noise by the application of noise limits at the nearest noise sensitive properties. ETSU-R-97 considers that absolute noise limits applied at all wind speeds are not suited to wind turbine developments and recommends that noise limits should be set relative to the existing background noise levels at noise sensitive locations. A critical aspect of the noise assessment of wind energy proposals relates to the identification of baseline noise levels through on-site noise surveys.

ETSU-R-97 states on page 58, "…*absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area which contribute to the noise received at the properties in question…*". Therefore, the noise contribution from all wind turbine development in the area should be included in the assessment.

The ETSU-R-97 guidance allows for a higher level of turbine noise operation at properties that have an involvement in the development, both as a higher fixed level of 45 dB L_{A90} and/or a higher level above the prevailing background noise level.

Wind Energy Development Guidelines for Planning Authorities

Section 5.6 of the *Wind Energy Development Guidelines for Planning Authorities* published by the Department of the Environment, Heritage and Local Government (2006) addresses noise and outlines the appropriate noise criteria in relation to wind farm developments.

The following extracts from this document should be considered:

> *"An appropriate balance must be achieved between power generation and noise impact."*

While this comment is noted it should be stated that the Guidelines give no specific advice in relation to what constitutes an 'appropriate balance'. In the absence of this, guidance will be taken from alternative and appropriate publications.

> *"In the case of wind energy development, a noise sensitive location includes any occupied house, hostel, health building or place of worship and may include areas of particular scenic quality or special recreational importance. Noise limits should apply only to those areas frequently used for relaxation of activities for which a quiet environment is highly desirable. Noise limits should be applied to external locations and should reflect the variation in both turbine source noise and background noise with wind speed."*

As can be seen from the calculations presented later in this chapter the various issues identified in this extract have been incorporated into our assessment.

> *"In general, a lower fixed limit of 45dB(A) or a maximum increase of 5dB(A) above background noise at nearby noise sensitive locations is considered appropriate to provide protection to wind energy development neighbours."*

This represents the commonly adopted daytime noise criterion curve in relation to wind farm developments. However, an important caveat should be noted as detailed in the following extract.

> *"However, in very quiet areas, the use of a margin of 5dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30dB(A), it is recommended that the daytime level of the* $L_{A90,\ 10min}$ *of the wind energy development be limited to an absolute level within the range of 35 – 40dB(A)."*

In relation to night time periods the following guidance is given:

> "*A fixed limit of 43dB(A) will protect sleep inside properties during the night.*"

This limit is defined in terms of the $L_{A90,10min}$ parameter. This represents the commonly adopted night time noise criterion curve in relation to wind farm developments.

In summary, the Wind Energy Development Guidelines outlines the following guidance to identify appropriate wind turbine noise criteria curves at noise sensitive locations:

- An appropriate absolute limit level in the range of 35 – 40 dB L_{A90} for quiet daytime environments with background noise levels of less than 30 dB $L_{A90,10min}$;
- 45 dB $L_{A90,10min}$ or a maximum increase of 5 dB above background noise (whichever is higher), for daytime environments with background noise levels of not less than 30 dB $L_{A90,10min}$ and;
- 43 dB $L_{A90,10min}$ for night time periods.

While the caveat of an increase of 5dB(A) above background for night-time operation is not explicit within the current guidance it is commonly applied in noise assessments prepared and is detailed in numerous examples of planning conditions issued by local authorities and An Bord Pleanála.

Planning Conditions for Operational Noise on Existing Wind Energy Developments in the Area

The permissible noise limits for Oweninny Phase 1 and 2 Wind Energy Developments are contained in Condition No. 7(i) and 7(ii) of An Bord Pleanála Reference PL16.PA0029:

> "*7. (i) The developer shall implement in full the proposals made in relation to mitigation measures for low noise environment as outlined in the environmental impact statement as revised (section 7).*
>
> *(ii) In all other areas noise levels emanating from the proposed development following commissioning, by itself or in combination with other existing or permitted wind energy development in the vicinity, when measured externally at third party noise-sensitive locations, shall not exceed the greater of 43 dB (A)$_{L90,\ 10min}$ or 5 dB above background noise levels."*

Condition 7(i) does not stipulate noise limits for low noise or quiet environments, rather it refers to the Environmental Impact Statement (EIS). The EIS has identified turbine noise limits at specific receivers that are applicable to existing wind turbine developments in the area through the planning condition. For noise sensitive locations where the contribution of turbine noise will predominately be from the operation of Oweninny Phase 1 and Phase 2 the existing turbine noise limits conditioned at these locations are deemed to be applicable. This is discussed further in Section 13.3.1.8.

A single wind turbine has been permitted at Dooleeg More (Mayo County Council Planning ref: P20/467). This permitted turbine is located approximately 3.25 km to the south of the nearest turbine in the Proposed Development. Condition 11 of the grant of permission issued by Mayo County Council in March 2021 relates to noise and states:

> "*11. During the operational period, noise levels resulting from the operation of the wind turbines when measured at the nearest inhabited house shall not exceed 45 dB(A) [sic] (15 minutes L_{eq}). All sound measurement shall be carried out in accordance with ISO*

Recommendations R 1996/1 (Acoustics – Description and Measurement of Environment Noise, Part 1: Basic Qualities and Procedures).

***Reason:** In the interest of residential amenity.*"

The condition imposes a fixed turbine noise limit of 45 dB $L_{Aeq,\ T}$ which equates to a lower threshold of 43 dB $L_{A90,T}$.

Institute of Acoustics Good Practice Guide

The original ETSU-R-97 concepts underwent a thorough standardisation and modernisation in 2013 with the Institute of Acoustics publication of the A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IOA GPG) including 6 Supplementary Guidance Notes. These documents bring together the combined experience of acoustic consultants in the UK and Ireland in the application of the assessment methods. Numerous improvements in the accuracy and robustness are described the treatment of wind shear and the general adaptation to larger wind turbines. The guidance contained within IOA GPG, and its Supplementary Guidance Notes are considered to represent best practice and have been adopted for this assessment.

The IOA GPG states, that at a minimum continuous baseline noise monitoring should be carried out at the nearest noise sensitive locations for typically a two-week period and should capture a representative sample of wind speeds in the area (i.e., cut in speeds to wind speed of rated sound power of the proposed turbine). Background noise measurements (i.e., $L_{A90,10min}$) should be related to wind speed measurements that are collated at the site of the wind turbine development. Regression analysis is then conducted on the data sets to derive background noise levels at various wind speeds to establish the appropriate day and night time noise criterion curves.

Noise emissions associated with the wind turbines can be predicted in accordance with ISO 9613: Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation (1996). This is a noise prediction standard that considers noise attenuation offered, amongst others, by distance, ground absorption, directivity, and atmospheric absorption. Noise predictions and contours are typically prepared for various wind speeds and the predicted levels are compared against the relevant noise criterion curve to demonstrate compliance with the appropriate noise criteria.

Where noise predictions indicate that reductions in noise emissions are required to satisfy any adopted criteria, consideration can be given to detailed downwind analysis and operating turbines in low noise mode, which is typically offered by modern wind turbine units.

For guidance on the methodology for the background noise survey and operation impact assessment for wind turbine noise the IOA GPG has been adopted.

The IOA GPG states that cumulative noise exceedances should be avoided and where existing or permitted development is at the noise limit, any new turbine noise sources should be designed to be 10 dB below the limit value.

Section 5.1 of the relevant IOA GPG states the following:

> "*5.1.1 ETSU-R-97 states at page 58, "…absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area which contribute to the noise received at the properties in question…"*
>
> *5.1.2 The HMP Report states that "If an existing wind farm has permission to generate noise levels up to ETSU-R-97 limits, planning permission noise limits set at any future neighbouring wind farm would have to be at least 10 dB lower than the limits set for the existing wind farm to ensure there is no potential for cumulative noise impacts to breach ETSU-R-97 limits (except in such cases where a higher fixed limit could be justified)". Such an approach could prevent any further wind farm development in the locality, and a more detailed analysis can be undertaken on a case by case basis.*
>
> *5.1.3 As with the assessment of noise for all wind farm developments, sequential steps need to be taken, but such steps require more detailed attention due to the added complexity of cumulative noise impacts. The advice of the EHO could be invaluable to this part of the assessment."*
>
> *Cumulative impact assessment necessary*
>
> *5.1.4 During scoping of a new wind farm development consideration should be given to cumulative noise impacts from any other wind farms in the locality. If the proposed*

wind farm produces noise levels within 10 dB of any existing wind farm/s at the same receptor location, then a cumulative noise impact assessment is necessary.

5.1.5 Equally, in such cases where noise from the proposed wind farm is predicted to be 10 dB greater than that from the existing wind farm (but compliant with ETSU-R-97 in its own right), then a cumulative noise impact assessment would not be necessary."

Future Potential Guidance Changes

In December 2019, the Draft Revised Wind Energy Development Guidelines (DREWED19) were published for consultation and at the time of writing, updated guidelines have yet to be published. It is important to note that during the public consultation several concerns relating to the proposed approach of the DRWEDG19 have been expressed by various parties. Specific concerns expressed by a group of acoustic professionals working in the field are most relevant. The group was made up of acousticians who act for wind farm developers, Councils, Government bodies and residents' groups (all of whom are members of the Institute of Acoustics, IOA . The group contained several of the authors / contributors to ETSU-R-97, the IOA Good Practice Guide (IOA GPG) and the IOA Amplitude Modulation Working Group, which are all referenced extensively in the draft guidelines. A statement from the cross party group can be reviewed at:

https://www.ioa.org.uk/wind-energy-development-guidelines-wedg-consultation-irish-department-housing-planning-community-and

The following statement is of note from the response :

"*a number of acousticians working in the field have raised serious concerns over the significant amount of technical errors, ambiguities and inconsistencies in the content of the draft WEDG and these were highlighted during the consultation process by a group of acousticians*"

It is AWN's opinion that the DRWEDG19 document does not outline a best practice approach in terms of the assessment of wind turbine noise. Furthermore, the DRWEDG19 have not been formally implemented and therefore, in line with best practice, the assessment presented in the EIAR is based on the current guidance outlined in the Wind Energy Development Guidelines for

Planning Authorities (2006) and has been supplemented with guidance from ESTU-R-97 and the IOA GPG and its supplementary guidance notes.

If updated Wind Energy Guidelines are published during the application process for the Proposed Development it is anticipated that any relevant changes affecting the noise will be addressed through an appropriate planning condition, or where a supplementary assessment is necessary, through provision of additional information.

World Health Organization (WHO) Noise Guidelines for the European Region

The WHO Environmental Noise Guidelines for the European Region (2018) provide guidance on protecting human health from exposure to environmental noise. They set health-based recommendations based on average environmental noise exposure of several sources of environmental noise, including wind turbine noise. Recommendations are rated as either 'strong' or 'conditional'. A strong recommendation, "*can be adopted as policy in most situations*" whereas a conditional recommendation, "*requires a policy-making process with substantial debate and involvement of various stakeholders. There is less certainty of its efficacy owing to lower quality of evidence of a net benefit, opposing values and preferences of individuals and populations affected or the high resource implications of the recommendation, meaning there may be circumstances or settings in which it will not apply*".

The objective of the WHO Environmental Noise Guidelines for the European Region is to provide recommendations for protecting human health from exposure to environmental noise from transportation, wind farm and leisure sources of noise. The guidelines present recommendations for each noise source type in terms of L_{den} and L_{night} levels above which there is risk of adverse health risks.

In relation to wind turbine noise, the WHO Guideline Development Group (GDG) state the following:

> *"For average noise exposure, the GDG conditionally recommends reducing noise levels produced by wind turbines below 45 dB L_{den}, as wind turbine noise above this level is associated with adverse health effects.*
>
> *No recommendation is made for average night noise exposure L_{night} of wind turbines. The quality of evidence of night-time exposure to wind turbine noise is too low to allow a recommendation.*

To reduce health effects, the GDG conditionally recommends that policy-makers implement suitable measures to reduce noise exposure from wind turbines in the population exposed to levels above the guideline values for average noise exposure. No evidence is available, however, to facilitate the recommendation of one particular type of intervention over another."

The quality of evidence used for the WHO research is stated as being 'Low', the recommendations are therefore conditional.

The WHO Environmental Noise Guidelines aim to support the legislation and policy-making process on local, national, and international level, thus shall be considered by Irish policy makers for any future revisions of Irish National Guidelines.

There is potential increased uncertainty due to the parameter used by the WHO for assessment of exposure (i.e., L_{den}), which it is acknowledged may be a poor characterisation of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes, as stated below, from within Environmental Noise Guidelines:

"Even though correlations between noise indicators tend to be high (especially between L_{Aeq}-like indicators) and conversions between indicators do not normally influence the correlations between the noise indicator and a particular health effect, important assumptions remain when exposure to wind turbine noise in Lden is converted from original sound pressure level values. The conversion requires, as variable, the statistical distribution of annual wind speed at a particular height, which depends on the type of wind turbine and meteorological conditions at a particular geographical location. Such input variables may not be directly applicable for use in other sites. They are sometimes used without specific validation for a particular area, however, because of practical limitations or lack of data and resources. This can lead to increased uncertainty in the assessment of the relationship between wind turbine noise exposure and health outcomes. Based on all these factors, it may be concluded that the acoustical description of wind turbine noise by means of L_{den} or L_{night} may be a poor characterization of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes."

…Further work is required to assess fully the benefits and harms of exposure to environmental noise from wind turbines and to clarify whether the potential benefits

> *associated with reducing exposure to environmental noise for individuals living in the vicinity of wind turbines outweigh the impact on the development of renewable energy policies in the WHO European Region."*

It is considered that the conditional WHO recommended average noise exposure level (i.e. 45 dB L_{den}) if applied, as target noise criteria for an existing or proposed wind turbine development in Ireland, should be done with caution. The conditional WHO recommendation for average noise exposure level (i.e., 45 dB L_{den}) may be a poor characterisation of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes.

13.2.2.5 Special Characteristics

Infrasound/Low Frequency Noise

Low Frequency Noise is noise that is dominated by frequency components less than approximately 200 Hz whereas Infrasound is typically described as sound at frequencies below 20 Hz. In relation to Infrasound, the following extract from the EPA document *Guidance Note for Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3)* (EPA, 2011) is noted here:

> *"There is similarly no significant infrasound from wind turbines. Infrasound is high level sound at frequencies below 20 Hz. This was a prominent feature of passive yaw "downwind" turbines where the blades were positioned downwind of the tower which resulted in a characteristic "thump" as each blade passed through the wake caused by the turbine tower. With modern active yaw turbines (i.e. the blades are upwind of the tower and the turbine is turned to face into the wind by a wind direction sensor on the nacelle activating a yaw motor) this is no longer a significant feature."*

With respect to infrasonic noise levels below the hearing threshold, the World Health Organisation (WHO) document *Community Noise* (WHO, 1995) has stated that:

> *"There is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects."*

In 2010, the UK Health Protection Agency published a report entitled *Health Effects of Exposure to Ultrasound and Infrasound, Report of the independent Advisory Group on Non-ionising Radiation*. The exposures considered in the report related to medical applications and general environmental exposure. The report notes:

> *"Infrasound is widespread in modern society, being generated by cars, trains and aircraft, and by industrial machinery, pumps, compressors and low speed fans. Under these circumstances, infrasound is usually accompanied by the generation of audible, low frequency noise. Natural sources of infrasound include thunderstorms and fluctuations in atmospheric pressure, wind and waves, and volcanoes; running and swimming also generate changes in air pressure at infrasonic frequencies.*
>
> *For infrasound, aural pain and damage can occur at exposures above about 140 dB, the threshold depending on the frequency. The best-established responses occur following acute exposures at intensities great enough to be heard and may possibly lead to a decrease in wakefulness. The available evidence is inadequate to draw firm conclusions about potential health effects associated with exposure at the levels normally experienced in the environment, especially the effects of long-term exposures. The available data do not suggest that exposure to infrasound below the hearing threshold levels is capable of causing adverse effects."*

The UK Institute of Acoustics Bulletin in March 2009 included a statement of agreement between acoustic consultants regularly employed on behalf of wind farm developers, and conversely acoustic consultants regularly employed on behalf of community groups campaigning against wind farm developments (IAO JS2009). The intent of the article was to promote consistent assessment practices, and to assist in restricting wind farm noise disputes to legitimate matters of concern. The article notes the following with respect to infrasound:

> *"Infrasound is the term generally used to describe sound at frequencies below 20 Hz. At separation distances from wind turbines which are typical of residential locations the levels of infrasound from wind turbines are well below the human perception level. Infrasound from wind turbines is often at levels below that of the noise generated by wind around buildings and other obstacles.*
>
> *Sounds at frequencies from about 20 Hz to 200 Hz are conventionally referred to as low-frequency sounds. A report for the DTI in 2006 by Hayes McKenzie concluded that*

neither infrasound nor low frequency noise was a significant factor at the separation distances at which people lived. This was confirmed by a peer review by a number of consultants working in this field. We concur with this view."

The article concludes that:

"from examination of reports of the studies referred to above, and other reports widely available on internet sites, we conclude that there is no robust evidence that low frequency noise (including 'infrasound') or ground -borne vibration from wind farms, generally has adverse effects on wind farm neighbours".

A report released in January 2013 by the South Australian Environment Protection Authority namely, *Infrasound levels near windfarms and in other environments* (EPA, 2013)[1] found that the level of infrasound from wind turbines is insignificant and no different to any other source of noise, and that the worst contributors to household infrasound are air-conditioners, traffic and noise generated by people.

The study included several houses in rural and urban areas, both adjacent to and away from a wind farm, and measured the levels of infrasound with the wind farms operating and switched off.

There were no noticeable differences in the levels of infrasound under all these different conditions. In fact, the lowest levels of infrasound were recorded at one of the houses closest to a wind farm, whereas the highest levels were found in an urban office building.

The EPA's study concluded that the level of infrasound at houses near wind turbines was no greater than in other urban and rural environments, and stated that:

"The contribution of wind turbines to the measured infrasound levels is insignificant in comparison with the background level of infrasound in the environment."

A German report[2], titled "*low frequency noise incl. infrasound from wind turbines and other sources*" presents the details of a measurement project which ran from 2013. The report was

[1] EPA South Australia, 2013, Wind farms https://www.epa.sa.gov.au/files/477912_infrasound.pdf

[2] Report available at https://www4.lubw.baden-wuerttemberg.de/servlet/is/262445/low-frequency_noise_incl_infrasound.pdf?command=downloadContent&filename=low-frequency_noise_incl_infrasound.pdf

published by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in 2016 and concluded the following in relation to infrasound from wind turbines:

> *"The measured infrasound levels (G levels) at a distance of approx. 150 m from the turbine were between 55 and 80 dB(G) with the turbine running. With the turbine switched off, they were between 50 and 75 dB(G). At distances of 650 to 700 m, the G levels were between 55 and 75 dB(G) with the turbine switched on as well as off.*
>
> *"For the measurements carried out even at close range, the infrasound levels in the vicinity of wind turbines – at distances between 150 and 300 m – were well below the threshold of what humans can perceive in accordance with DIN 45680 (2013 Draft)[3]"*
>
> *"The results of this measurement project comply with the results of similar investigations on a national and international level."*

In conclusion, there is a significant body of evidence to show that the infrasound associated with wind turbines will be below perceptibility thresholds and typically in line with existing baseline levels of infrasound within the environment.

Amplitude Modulation

In the context of this assessment, amplitude modulation (AM) is defined in the IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) document *A Method for Rating Amplitude Modulation in Wind Turbine* (IOA, 2016) as:

> *"Periodic fluctuations in the level of audible noise from a wind turbine (or wind turbines), the frequency of the fluctuations being related to the blade passing frequency (BPF) of the turbine rotor(s)."*

It is now generally accepted that there are two mechanisms which can cause amplitude modulation:

- 'Normal' AM, and;

[3] DIN 45680:2013-09 – Draft "Measurement and assessment of low-frequency noise immissions" November 2013

- 'Other' AM (sometimes referred to 'Excessive' AM).

In both cases, the result is a regular fluctuation in amplitude at the Blade Passing Frequency (BPF) of the wind turbine blades (the rate at which the blades of the turbine pass a fixed point). For a three-bladed turbine rotating at 20 rpm, this equates to a modulation frequency of 1 Hz.

'Normal' AM An observer at ground level close to a wind turbine will experience 'blade swish' because of the directional characteristics of the noise radiated from the trailing edge of the blades as it rotates towards and then away from the observer.

This effect is reduced for an observer on or close to the turbine axis, and therefore would not generally be expected to be significant at typical separation distances, at least on relatively level sites.

The RenewableUK AM project (RenewableUK, 2013) has coined the term 'normal' AM (NAM) for this inherent characteristic of wind turbine noise, which has long been recognised and was discussed in ETSU-R-97 in 1996.

'Other' AM In some cases AM is observed at large distances from a wind turbine (or turbines). The sound is generally heard as a periodic 'thumping' or 'whoomphing' at relatively low frequencies.

On sites where it has been reported, occurrences appear to be occasional, although they can persist for several hours under some conditions, dependent on atmospheric factors, including wind speed and direction.

It was proposed in the RenewableUK 2013 study that the fundamental cause of this type of AM is transient stall conditions occurring as the blades rotate, giving rise to the periodic thumping at the blade passing frequency.

Transient stall represents a fundamentally different mechanism from blade swish and can be heard at relatively large distances, primarily downwind of the rotor blade.

The RenewableUK AM project report adopted the term 'Other AM' (OAM) for this characteristic. The terms 'enhanced' or 'excess' AM (EAM) have been used by others, although such definitions do not distinguish between the source mechanisms and presuppose a 'normal' level of AM, presumably relating back to blade swish as described in ETSU-R-97.

Frequency of Occurrence of AM

Research by Salford University commissioned by the Department of Environment Food and Rural Affairs (DEFRA), the Department of Business, Enterprise and Regulatory Reform (BERR) and the Department of Communities and Local Government (CLG) investigated the issue of AM associated with wind turbine noise. The results were reviewed and published in the report 'Research into Aerodynamic Modulation of Wind Turbine Noise' (2007). The broad conclusions of this report were that aerodynamic modulation was only considered to be an issue at four, and a possible issue at a further eight, of 133 sites in the UK that were operational at the time of the study and considered within the review. At the four sites where AM was confirmed as an issue, it was considered that conditions associated with AM might occur between about 7 and 15% of the time. It also emerged that for three out of the four sites the complaints have subsided, in one case due to the introduction of a turbine control system. The research has shown that AM is a rare and unlikely occurrence at operational wind farms.

It should be noted that AM is associated with wind turbine operation and it is not possible to predict an occurrence of AM at the planning stage. It should also be noted that it is a rare event associated with a limited number of wind farms. While it can occur, it is the exception rather than the rule.

RenewableUK Research Document states the following in relation to matter:

Page 68 Module F *"even on those limited sites where it has been reported, its frequency of occurrence appears to be at best infrequent and intermittent."*

Page 6 Module F	*"It has also been the experience of the project team that, even at those wind farm sites where AM has been reported or identified to be an issue, its occurrence may be relatively infrequent. Thus, the capture of time periods when subjectively significant AM occurs may involve elapsed periods of several weeks or even months."*
Page 61 Module F	*"There is nothing at the planning stage that can presently be used to indicate a positive likelihood of OAM occurring at any given proposed wind farm site, based either on the site's general characteristics or on the known characteristics of the wind turbines to be installed."*

Assessment of AM

Research and Guidance in the area is ongoing with recent publications being issued by the Institute of Acoustics (IOA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely, A Method for Rating Amplitude Modulation in Wind Turbine Noise (August 2016) (The Reference Method). The document proposes an objective method for measuring and rating AM. The AMWG does not propose what level of AM is likely to result in adverse community response or propose any limits for AM. The purpose of the group is simply to use existing research to develop a Reference Methodology for the measurement and rating of amplitude modulation.

The definition of any limits of acceptability for AM, or consideration of how such limits might be incorporated into a wind farm planning condition, is outside the scope of the AMWG's work and is currently the subject of a separate UK Government funded study.

Where it occurs, AM is typically an intermittent occurrence, therefore assessment may involve long-term measurements. The 'Reference Method' for measuring AM outlined in the IOA AMWG document will provide a robust and reliable indicator of AM and yield important information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions.

Comment on Health Impacts

The peer reviewed research outlined in the proceeding section supports that there are no direct negative health effects on people with long term exposure to wind turbine noise in the environment. For further details of potential health impacts associated with the Proposed Development. please refer to Chapter 6 Population and Human Health of the EIAR, specifically Section 6.4.2.2.1 (Wind Turbine Health Effects) which references a review of the existing literature undertaken in 2011 by Knopper (Knopper, 2011). The results of this study were stated as follows:

To date, no peer reviewed articles demonstrate a direct causal link between people living in proximity to modern wind turbines, the noise they emit and resulting physiological health effects.

The National Health and Medical Research Council

The relevant Australian authority on health issues, the National Health and Medical Research Council (NHMRC), conducted a comprehensive independent assessment of the scientific evidence on wind farms and human health. The findings are contained in the NHMRC Information Paper: Evidence on Wind Farms and Human Health 2015, which concluded:

> *"After careful consideration and deliberation, NHMRC concluded that there is no consistent evidence that wind farms cause adverse health effects in humans. This finding reflects the results and limitations of the direct evidence and also takes into account the relevant available parallel evidence on whether or not similar noise exposure from sources other than wind farms causes health effects"*

Health Canada

Health Canada, Canada's national health organisation, released preliminary results of a study into the effect of wind farms on human health in 2014[4]. The study was initiated in 2012 specifically to gather new data on wind farms and health. The study considered physical health

4 Health Canada 2014, Wind Turbine Noise and Health Study: Summary of Results. Available at https://www.canada.ca/en/health-canada/services/environmental-workplace-health/noise/wind-turbine-noise/wind-turbine-noise-health-study-summary-results.html

measures that assessed stress levels using hair cortisol, blood pressure and resting heart rate, as well as measures of sleep quality. More than 4,000 hours of wind turbine noise measurements were collected and a total of 1,238 households participated.

No evidence was found to support a link between exposure to wind turbine noise and any of the self-reported illnesses. Additionally, the study's results did not support a link between wind turbine noise and stress or sleep quality (self-reported or measured). However, an association was found between increased levels of wind turbine noise and individuals reporting of being annoyed.

New South Wales Health Department

In 2012, the New South Wales (NSW) Health Department provided written advice to the NSW Government that stated existing studies on wind farms and health issues had been examined and no known causal link could be established.

NSW Health officials stated that fears that wind turbines make people sick are 'not scientifically valid'. The officials wrote that there was no evidence for 'wind turbine syndrome', a collection of ailments including sleeplessness, headaches and high blood pressure that some people believe are caused by the noise of spinning blades.

The Australian Medical Association

The Australian Medical Association put out a position statement, *Wind Farms and Health* 2014[5]. The statement said:

> *"The available Australian and international evidence does not support the view that the infrasound or low frequency sound generated by wind farms, as they are currently regulated in Australia, causes adverse health effects on populations residing in their vicinity. The infrasound and low frequency sound generated by modern wind farms in Australia is well below the level where known health effects occur, and there is no accepted physiological mechanism where sub-audible infrasound could cause health effects."*

Journal of Occupational and Environmental Medicine

The review titled, Wind Turbines and Health: A Critical Review of the Scientific Literature was published in the Journal of Occupational and Environmental Medicine, 2014. An independent review of the literature was undertaken by the he Department of Biological Engineering of the Massachusetts Institute of Technology (MIT). The review took into consideration health effects such as stress, annoyance and sleep disturbance, as well as other effects that have been raised in association with living close to wind turbines. The study found that:

> *"No clear or consistent association is seen between noise from wind turbines and any reported disease or other indicator of harm to human health."*

The report concluded that living near wind farms does not result in the worsening of the quality of life in that particular region.

5 Australian Medical Association, 2014, Wind farms and health. Available https://ama.com.au/position-statement/wind-farms-and-health-2014

13.2.2.6 Operational Phase Vibration

Vibration generated from the operation of a wind turbine unit will decrease rapidly with distance. Typically, at 100 m from a 1 MW turbine unit the level of vibration associated with a turbine is the order of 10^{-5} mm/s.

A recent report from Germany published by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in 2016, "*low frequency noise incl. infrasound from wind turbines and other sources*" conducted vibration measurements study for an operational Nordex N117 – 2.4 MW wind turbine. The report concluded that at distances of less than 300 m from the turbine vibration levels had dropped so far that they could no longer be differentiated from the background vibration levels.

The shortest distance from any turbine in the Proposed Development to the nearest NSL is in excess of 1,160 m (distance from turbine T16 to NSL ref. R10). At that distance, the level of vibration will be significantly below any thresholds for perceptibility. Therefore, vibration criteria have not been specified for the operational phase of the Proposed Development.

13.2.3 Assessment Methodology

13.2.3.1 Background Noise Survey

A background noise survey was undertaken to determine typical background noise levels at representative NSL's surrounding the development site. The background noise survey was conducted through installing unattended sound level meters at 6 no. representative locations in the surrounding area.

All measurement data collected during the background noise surveys has been carried out in accordance with the IOA GPG and accompanying Supplementary Guidance Note 1: *Data Collection* (2014) discussed in the following Section.

Choice of Measurement Locations

The noise monitoring locations were identified by preparing a preliminary noise model contour at an early stage of the assessment. Any locations that fell inside the predicted 35 dB L_{A90} noise contour was considered for noise monitoring in line with current best practice guidance outlined in the IOA GPG. The selection of the noise monitoring locations was informed by a site visit and supplemented by reviewing aerial images of the study area and other online sources of information (e.g., Google Earth and OSI Maps).

The co-ordinates for selected locations for the noise monitoring are outlined in Table 13.1.

The sound level meter at NML-3 was moved by approximately 40 m during the survey, the move was requested by the landowner to accommodate farming activities.

Study Area

The study area for the noise and vibration impact assessment was defined by the area where there is potential for noise and vibration impacts at Noise Sensitive Locations (NSLs) associated with the Proposed Development during the Construction, decommissioning, and Operational Phases.

Due to the potential for cumulative impact with other existing permitted and proposed wind turbine developments, the study area for the operational phase of the Proposed Development should cover at least the area predicted to exceed 25 dB L_{A90} at the maximum predicted noise emission level.

During the Construction and Decommissioning Phases noise could occur at any location within the planning application boundary but is most likely, in proximity to specific sites and on haul routes. Taking account of the typical works associated with the Construction and Decommissioning phases, the study area is based on the nearest NSLs to the working areas, these distances are confirmed in the relevant sections and are typically representative of the closest identified NSLs or at defined set back distances from the works.

Table 13-4 Noise Measurement Co-ordinates

Location Ref.	Location I.D.	Co-ordinates (ITM)	
		Easting	Northing
NML-1	R07	505,434	824,094
NML-2	R10	504,831	822,092
NML-3 (a)	R16	503,892	820,120
NML-3 (b)		503,856	820,141
NML-4	R44	502,552	818,364
NML-5	R73	497,731	821,656
NML-6	R74 (proxy location on BnM land)	497,322	823,129

Site visits by survey personnel were carried out during the morning and afternoon time; during these visits, primary noise sources contributing to noise build-up were noted. In respect of night-time periods, when noise due to traffic on local roads, agricultural activities and other sources tend to reduce, there was no indication of any significant local night-time sources of noise at any location.

Noise from the operation of existing turbines was not noted to be audible at any of the locations during site visits. It should be noted that the level of wind turbine noise is variable, it is dependent on the operational condition of the turbine, wind speed and direction, distance from the turbines, and the levels of background noise at the location.

It is important to note that any noise from the existing wind turbines in the area should not form part of the background noise environment at noise sensitive locations. This issue is discussed further later in this section.

No significant sources of vibration were noted at any of the survey locations.

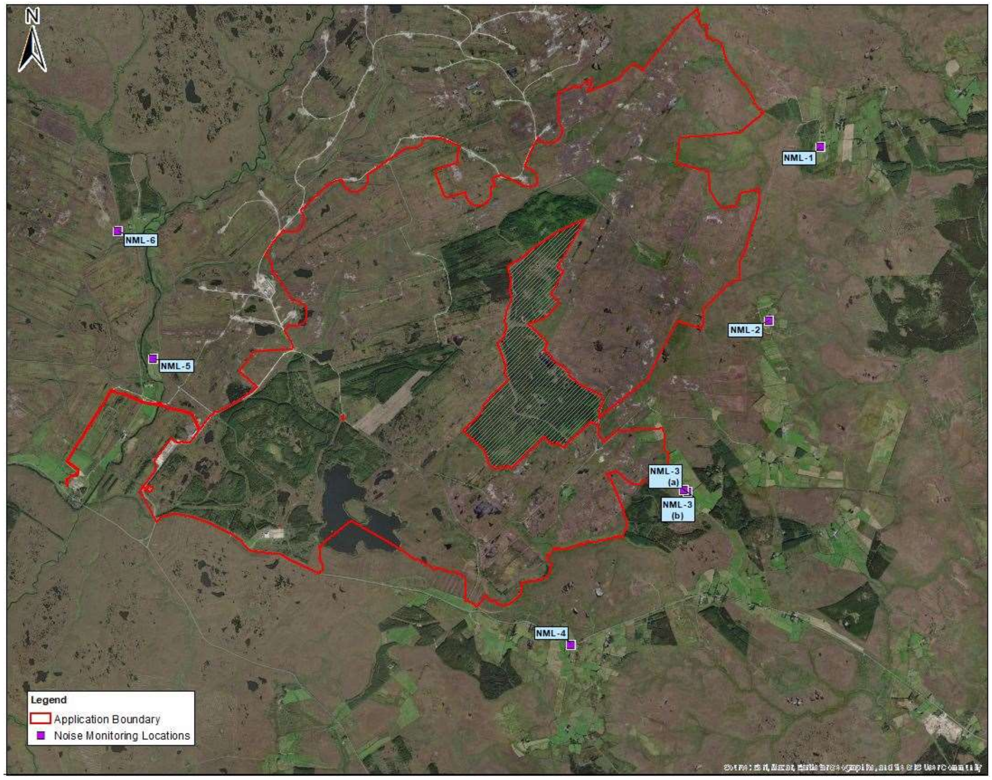

Figure 13.2 Noise Monitoring Locations

Figure 13.3 to Figure 13.9 illustrate the installed noise monitoring kits at each location.

Location NML1 (R07)

At NML1, the noise monitor was positioned in the Garden or field to the south of the dwelling the location was noted to be quiet with very little road traffic audible, the main source of noise was low-level wind generated noise in the surrounding foliage. There was some noise audible from the heating system in the vicinity of the dwelling, but this noise was not audible at the measurement position. The nearest existing turbine at Oweninny Phase 1 wind farm is located over 3 km to the east and no audible turbine noise was noted at NML1. NML1 is deemed to be representative of the typical background noise environmental at the cluster of Noise sensitive receivers located to the west of the Proposed Development (R02 – R09).

Figure 13.3 Noise Monitoring Installation – NML-1

Location NML2 (R10)

At NML2, the noise monitor was positioned in the field to the west of the dwelling. The location was noted to be quiet with very little road traffic noise or other sources audible. The nearest existing operational turbines at Oweninny Wind Farm Phase 1 or Bellacorick Wind Farm are located over 3 km away and no audible turbine noise was noted at NML2 during site visits.

Figure 13.4 Noise Monitoring Installation – NML-2

Location NML3 (R16)

At NML3, the noise monitor was positioned in a field to the north of the dwelling and farm to avoid influence from noise sources in and around the dwelling and farm. The main source of noise was occasional farming activity and distance road traffic noise from N59. The nearest existing turbines at Oweninny Wind Farm Phase 1 or Bellacorick Wind Farm are located over 3 km to the northwest and no audible turbine noise was noted at NML3. NML3 is deemed to be representative of the typical background noise environmental at the cluster of noise sensitive receivers located to the southeast of the Proposed Development which are setback from the N59.

Figure 13.5 Noise Monitoring Installation – NML-3(a)

Figure 13.6 Noise Monitoring Installation – NML-3(b)

Location NML4 (R44)

At NML4, the noise monitor was positioned in the front garden of the dwelling. The main source of noise was noted to be road traffic noise from N59. The nearest existing turbines is at the Bellacorick Wind Farm and is located approximately 3.8 km to the north; no audible turbine noise was noted at NML4. NML4 is deemed to be representative of the typical background noise environmental at noise sensitive receivers located to the southeast of the Proposed Development close to the N59 road.

Figure 13.7 Noise Monitoring Installation – NML-4

<u>Location NML5 (R73)</u>

At NML5, the noise monitor was to the rear of the dwelling on the eastern side. Turbine noise was not audible during site visits. Distant road traffic noise from the N59 was noted to be audible in the background. The nearest existing turbines at Oweninny Wind Farm Phase 1 and Bellacorick Wind Farms are located over 1 km to the east.

Figure 13.8 Noise Monitoring Installation – NML-5

Location NML6 (proxy location on BnM land for location R74)

At NML6, the noise monitor was positioned in a field on BnM land approximately 160 m west of location R74. Turbine noise was not audible during site visits. The nearest existing turbine is at Oweninny Wind Farm Phase 1 and is located over 1 km to the east.

Figure 13.9 Noise Monitoring Installation – NML-6

Measurement Periods

The survey duration was typically 4 weeks, or until such time that enough data points were captured at each survey locations. Section 2.9.1 of the IOA GPG states:

> *"The duration of a background noise survey is determined only by the need to acquire sufficient valid data over the range of wind speeds (and directions, if relevant). It is unlikely that this requirement can be met in less than 2 weeks."*

AWN conducted an ongoing review of the survey data at regular intervals to establish when adequate data had been captured.

Noise measurements were conducted at relevant monitoring locations over the following periods:

Table 13-5 Noise Measurement Periods

Location Ref.	Location I.D.	Start Time	End Time
NML-1	R07	26/11/2020	06/01/2021
NML-2	R10	26/11/2020	14/01/2021
NML-3 (A)	R16	26/11/2020	18/12/2020
NML-3 (B)		18/12/2020	01/02/2021
NML-4	R44	26/11/2020	09/01/2021
NML-5	R73	26/11/2020	13/01/2021
NML-6	R74	26/11/2020	01/02/2021

A variety of wind speed and weather conditions were encountered over the survey periods in question. As an indication to this, Figure 13.10 shows the distribution of wind speed and direction recorded at the met masts for all periods of day and night between the 26th of November and 1st of February 2021. The wind speed data presented below relates to a turbine hub height of 121 m.

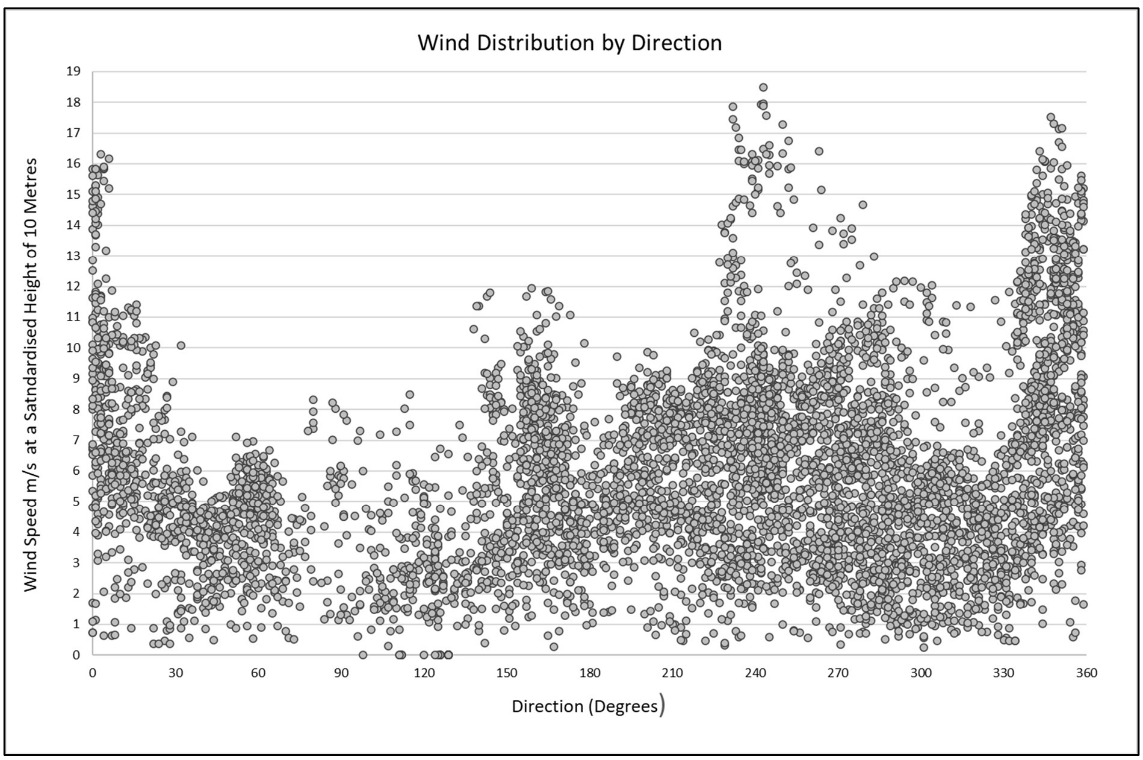

Figure 13.10 Distribution of Wind Speeds and Direction at Met Mast during Survey Period

It is confirmed that survey periods were of sufficient duration to measured adequate data to determine a suitable representation of typical background at all locations in accordance with guidance contained within the IOA GPG.

Instrumentation

The following instrumentation was used at the various locations:

Table 13-6 Noise Measurement Instrumentation

Location	Equipment	Serial Number	Calibration Drift over Survey Period
NML-1	Rion NL-52	575802	0
NML-2	Rion NL-52	575785	-0.2
NML-3 (a)	Rion NL-52	186668	0.5
NML-3 (b)	Rion NL-52	186668	0.4
NML-4	Rion NL-52	186667	0.1
NML-5	Rion NL-52	998411	0.1
NML-6	Rion NL-52	186672	0

Before, after and during each survey period, the measurement instrument was checked and calibrated using a Brüel & Kjær type 4231 Sound Level Calibrator. The calibration drifts were noted, and the maximum drifts are detailed in Table 13-6 above. Relevant calibration certificates are presented in Appendix 13.2.

Rainfall was monitored using two rain gauges installed at Location NML-1 and NML-5. The rainfall data allows for the identification of periods of rainfall so that they can be removed from the noise monitoring data sets, in line with best practice, when calculating the prevailing background noise levels at the various locations.

Wind speed measurements were obtained from an onsite met mast with anemometers situated at 100 m and 84 m. The location of the met mast is provided in Table 13-7.

Table 13-7 Met Mast Locations

Met Mast	Co-ordinates (ITM)

	Easting	Northing
Shanvodinnaun	503,766	822,297

Measurement Procedure

Measurements were conducted at all locations over the survey periods outlined in *Table 13-6*. Data samples for all measurements (noise, rainfall, and wind) were logged continuously at 10-minute interval periods for the duration of the survey. The $L_{Aeq,10min}$ and $L_{A90,10min}$ noise parameters were measured in this instance and the results were saved to the instrument memory for later analysis.

Survey personnel noted potential primary noise sources contributing to noise build-up during the installation and removal of the sound level meters from site. Description of the observed noise environment at each of the monitoring locations is presented below.

Consideration of Wind Shear

As part of a robust wind farm noise assessment due consideration should be given to the issue of wind shear. It is standard procedure to reference noise data to standardised 10 metre wind speed. Wind shear has been considered in this assessment in accordance with the guidance contained in the IOA GPG, Supplementary Guidance Note (SGN) 4: Wind Shear, July 2014. This guidance presents the following equations in relation to the derivation of a standardised wind speed at 10 m above ground level:

Equation A Shear Exponent Profile: this uses the following equation:

$$U = U_{ref}\left[\frac{H}{H_{ref}}\right]^m$$

Where:

U calculated wind speed.

U_{ref} measured wind speed.

H height at which the wind speed will be calculated.

H_{ref} height at which the wind speed is measured.

m shear exponent.

Equation B Roughness Length Shear Profile: this uses the following equation:

$$U_1 = U_2 \frac{\ln(H_1/z)}{\ln(H_2/z)}$$

Where:

H_1 the height of the wind speed to be calculated (10m)

H_2 the height of the measured wind speed.

U_1 the wind speed to be calculated.

U_2 the measured wind speed.

z the roughness length.

Note: A roughness length of 0.05m is used to standardise hub height wind speeds to 10m height in the IEC 61400-11:2003 standard, regardless of what the actual roughness length seen on a site may have been. This 'normalisation' procedure was adopted for comparability between test results for different turbines.

The derived background noise levels at integer wind speeds (standardised 10 m height) is dependent on the specific hub height; an assessment hub height of 121 m has been used in this assessment. Any reference to wind speed in the following sections of this chapter should be understood to be the standardised 10 m height wind speed reference unless otherwise Stated.

Atypical Noise Data

The data sets have been filtered to remove issues such as the dawn chorus and the influence of other atypical noise sources. An example of atypical sources would be short, isolated periods of raised noise levels attributable to local sources, agricultural activity, boiler flues, operation of gardening equipment etc. In addition, sample periods affected by rainfall or when rainfall resulted in prolonged periods of atypical noise levels have also been screened form the data sets.

Assessment Periods

The results presented in the following sections refer to the noise data collated during 'quiet periods' of the day and night as defined in the IOA GPG. These periods are defined as follows:

- Daytime Amenity hours are:
  - all evenings from 18:00 to 23:00hrs;
  - Saturday afternoons from 13:00 to 18:00hrs, and;
  - all day Sunday from 07:00 to 18:00hrs.
- Night time hours are 23:00 to 07:00hrs.

The assessment methods outlined above are in line with the guidance contained in the IOA GPG.

Noise from existing Turbines

Any influence of noise from existing turbines in the measurements needs to be addressed and corrected for where necessary. Therefore, consideration has been given to removing contributing noise from existing turbines. It is important to note that any noise from the existing wind turbines in the area should not significantly influence the overall background noise levels derived at noise sensitive locations.

Steps have been taken to remove any turbine noise from existing turbines in the analysis of the background noise data. For guidance, reference has been made to Section 5.2.3 of the IOA GPG which states the following:

> "*5.2.3 In the presence of an existing wind farm, suitable background noise levels can be derived by one of the following methods:*
>
> - *switching off the existing wind farm during the background noise level survey (with associated cost implications);*

- *accounting for the contribution of the existing wind farm in the measurement data e.g. directional filtering (only including background data when it is not influenced by the existing turbines e.g. upwind of the receptor, but mindful of other extraneous noise sources e.g. motorways) or subtracting a prediction of noise from the existing wind farm from the measured noise levels;*
- *utilising an agreed proxy location removed from the area acoustically affected by the existing wind farm/s; or utilising background noise level data as presented within the Environmental Statement/s for the original wind farm/s (the suitability of the background noise level data should be established)."*

The method adopted in this assessment was directional filtering with due consideration to the predicted turbine noise for existing operation turbines. Directional filter is done to filter the measured noise data when it is least influenced by the existing turbines e.g., upwind of the receptor.

13.2.3.2 Construction Noise Calculations

A variety of items of plant will be used for the purposes of site preparation, construction, and site works. There will be vehicular movements to and from the site that will make use of existing roads. There is the potential for generation of significant levels of noise from these activities.

Due to the nature of construction activities, it is difficult to calculate the actual magnitude of emissions to the local environment in the absence of a detailed construction programme. The standard best practice approach is to predict typical noise levels at the NSLs using guidance set out in British Standard BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*. Construction noise predictions have been carried out using guidance set out in BS 5228-1.

The methodology adopted for the assessment of construction noise is to analyse the various elements of the construction phase in isolation. For each element, the typical construction noise sources are assessed along with typical sound pressure levels and spectra from BS 5228-1 at various distances from these works.

13.2.3.3 Operational Noise Calculations

A series of computer-based prediction models have been prepared to quantify the potential turbine noise level associated with the operational phase of the proposed development on the receiving environment. This section discusses the methodology behind the noise modelling process and presents the results of the modelling exercise.

DGMR iNoise V2022 Enterprise

The selected software, DGMR *iNoise Enterprise*, calculates noise levels in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation*, (ISO, 1996).

iNoise is a proprietary noise calculation package for computing noise levels and propagation of noise sources. iNoise calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated considering a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of A weighted sound power levels (LWA);
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impacts at distances greater than approximately 400 m).

Input Data and Assumptions

Information available for the site was inputted into AWNs iNoise noise modelling software using the ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors: General method of calculation.* The input data and assumptions made are described in the following sections.

Proposed Turbine Details

Table 13-8 details the co-ordinates of the turbines of the Proposed Development that are being considered as part of this assessment.

Table 13-8 Proposed Turbine Co-ordinates

Turbine Ref.	Co-ordinates (ITM)		Top of Foundation (mOD)
	Easting	Northing	
T01	499,875	822,583	86.5
T02	500,488	821,872	86.5
T03	500,999	822,389	90.5
T04	500,616	822,656	89.0
T05	500,123	822,125	84.5
T06	500,601	823,420	95.5
T07	501,436	823,180	98.0
T08	502,963	823,949	100.5
T09	503,337	824,592	99.5
T10	503,820	825,172	96.5
T11	502,968	823,036	101.5
T12	502,512	821,912	104.5
T13	502,971	821,460	100.5
T14	503,160	822,629	99.5
T15	503,316	822,150	101.0
T16	503,937	822,803	94.5
T17	503,771	823,208	89.5
T18	503,501	823,616	92.5

The assessment has been undertaken for a turbine hub height of 121 m, a rotor diameter of 158 m and a tip height of 200 m over the top of foundation level. The following section presents details of the sound power level data for the turbine unit that have been used for the operational turbine noise prediction modelling assessment.

The turbine noise levels at NSLs have been predicted for a range of operational wind speeds based on the source of noise at a hub height of 121 m and noise emission data for the GE Renewable Energy turbine Model GE158.

While the noise profiles of the GE158[6] wind turbine has been used for the purposes of this assessment, the actual turbine to be installed on the site will be the subject of a competitive tender process and may include other turbine manufacturers and/or turbine models. The wind turbine eventually selected for installation on site will not give rise to noise levels of greater

[6] GE Renewable Energy: Noise_Emission_4.x/5.x-158-50 Hz_IEC_EN_r01

significance than that used for the purposes of this assessment, to ensure the findings of this assessment remain valid. Any references to the GE158 turbines in this assessment must be considered in the context of the above and should not be construed as meaning it is the only make or model of wind turbine that could be installed on the site.

An appraisal of the wider study area around the proposed wind farm site identified that the nearest operational wind farms are Oweninny Wind Farm Phase 1 and Bellacorick. If the proposed development is constructed the Bellacorick wind farm will be decommissioned. Therefore, the Bellacorick Wind Farm is not included in the noise prediction model for the proposed development. The Oweninny Phase 2 wind farm has been included in the noise prediction model; this wind farm was not constructed at the time of the background noise survey.

A single wind turbine has been permitted at Dooleeg More (Mayo County Council Planning ref: P20/467). This permitted turbine is located approximately 3.25 km from the nearest turbine of the Proposed Development. A review of the proposed Dooleeg More turbine with reference to the technical details contained in the planning submission (see Appendix 13.3) has confirmed that there is no potential for cumulative impacts of any significance, and it is not required to include this turbine in the operational noise prediction models. A similar assessment considering the consented Sheskin Wind Farm (Mayo County Council Planning ref: 19/457), and the proposed the Sheskin South Wind Farm (Planning ref. ABP-310529-21), it was confirmed that in accordance with the IOAGPG guidance, these turbines did not need to be included in the cumulative turbine noise assessment for the EIAR. The contribution of turbine noise from the operation of the permitted Sheskin Wind Farm and proposed Sheskin South Wind Farm at NSLs within the study area is not significant.

The details and coordinates of the other wind farms considered in the assessment are presented in Appendix 13.3.

A 13-turbine wind farm development, known as the Kilsallagh Wind Farm, is planned by EDF Renewables approximately 8km south-west of the proposed Oweninny Wind Farm Phase 3. To date, no planning application has been lodged and there is no information further available for the proposed Kilsalagh Wind Farm. However, considering the distance from the proposed development, the potential for cumulative impacts is not significant and it is not necessary to consider cumulative noise from any other wind farms in the assessment of the Proposed Development.

Table 13-9 details the turbine noise data used in the noise predictions models for the Proposed Development. The octave-band frequency spectra used for this turbine and all other turbines considered in the assessment are presented in Appendix 13.3.

Table 13-9 L_{WA} Levels Used for Prediction Model – GE158 5.5MW with 121 m Hub Height

Wind Speed (m/s at 10m Standardised Height)	dB L_{WA}
3	94.1
4	97.2
5	102.0
6	105.6
7	106.0
8	106.0
9	106.0

The manufacturer's turbine sound power levels outlined in Table 13-9 are derived based on measurements in terms of the L_{Aeq} acoustic parameter. In accordance with best practice guidance contained within the Institute of Acoustics Good Practice Guide (IOA GPG), an allowance for uncertainty in the measurement of turbine source levels of +2 dB is applied in modelling to all turbine sound power levels presented in the tables above.

Moreover, as explained below in Section 13.2.2.4, appropriate guidance is couched in terms of a L_{A90} criterion. Best practice guidance in the IOA GPG states that "*L_{A90} levels should be determined from calculated L_{Aeq} levels by subtraction of 2 dB*". Therefore, a 2 dB reduction has been applied to the noise model output. All predicted noise levels in this chapter are presented in terms of L_{A90}, i.e., this reduction of 2 dB is applied in the noise prediction modelling.

Best practice specifies that should any tonal component be present, a penalty shall be added to the predicted noise levels. The level of this penalty is described in ETSU-R-97 and is related to the level by which any tonal components exceed audibility. For the purposes of this assessment a tonal penalty has not been included within the predicted noise levels. A warranty will be provided by the manufacturers of the selected turbine to ensure that the noise output will not require a tonal noise correction under best practice guidance.

Modelling Calculation Parameters[7]

Prediction calculations for turbine noise have been conducted in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation*, 1996.

In terms of calculation a ground attenuation factor (general method) of 0.5 and no metrological correction were assumed for all calculations. The atmospheric attenuation outlined in Table 13-10 were used for all calculations in accordance with the guidance outlined in the IOA GPG.

Table 13-10 Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

Temp (°C)	% Humidity	Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
10	70	0.12	0.41	1.04	1.92	3.66	9.70	33.06	118.4

When considering noise impacts of wind turbines, the effects of propagation in different wind directions can be considered. As previously stated, the day to day operations of the proposed development will not result in a worst-case condition of all NSLs being downwind of all turbines at the same time i.e., omni-directional predictions. Therefore, to address this issue, a review of expected noise levels downwind of the turbines has been prepared for various wind directions in accordance with the IOA GPG Guidance.

For any given wind direction, a property can be assigned one of the following classifications in relation to turbine noise propagation:

- Downwind (i.e., 0° ±80°).
- Crosswind (i.e., 90° ±10° and 270° ±10°).
- Upwind (i.e., 180° ±80°).

Figure 13.11 illustrates the directivity attenuation factor that has been applied to turbines when considering noise propagation in downwind conditions.

7 See Appendix 13.3 for further discussion of calculation parameters.

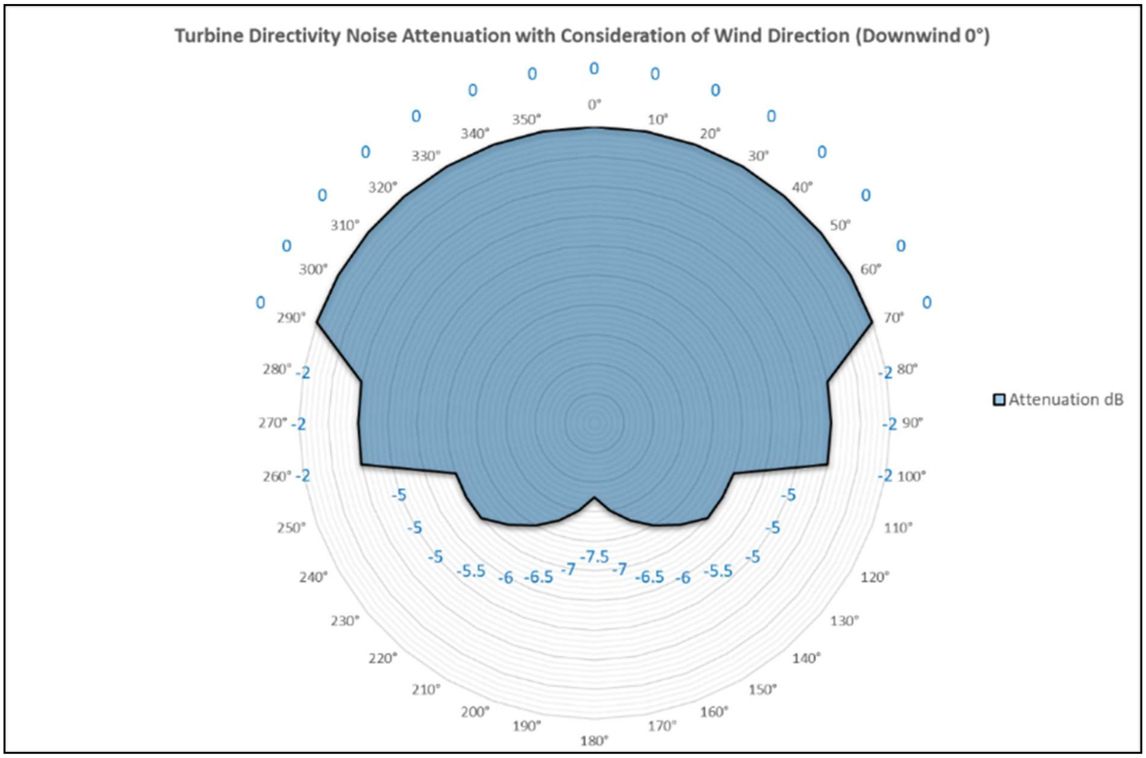

Figure 13.11 Turbine Directivity Attenuation with Consideration of Wind Direction

13.2.3.4 Additional Information

Appendix 13.3 details the NSLs used in this assessment. Noise predictions were prepared in respect of the various operational turbine wind speeds at these locations.

13.3 EXISTING ENVIRONMENT

This section of the report documents the typical background noise levels measured in the vicinity of the NSLs in closest proximity to the proposed development site.

13.3.1 Background Noise Levels

The following sections present an overview and results of the noise monitoring data obtained from the background noise survey in accordance with the methodology discussed in Section 13.2.3.1.

The noise environment was observed during installations, site visits to maintain equipment, and equipment collections. In general, the significant noise sources in the area were noted to be local and distant traffic movements, activity in and around the residences, wind generated noise from local foliage and other typical anthropogenic sources typically found in such rural settings. The directional filters applied to the data is outlined in the relevant sections.

13.3.1.1 NML1

NML1 is situated to the east of existing turbines. For daytime and night time periods, the data has been filtered to include only wind directions between 0 and 195 degrees, which represents upwind conditions from operational turbines. The resulting background noise levels are presented in Table 13-11.

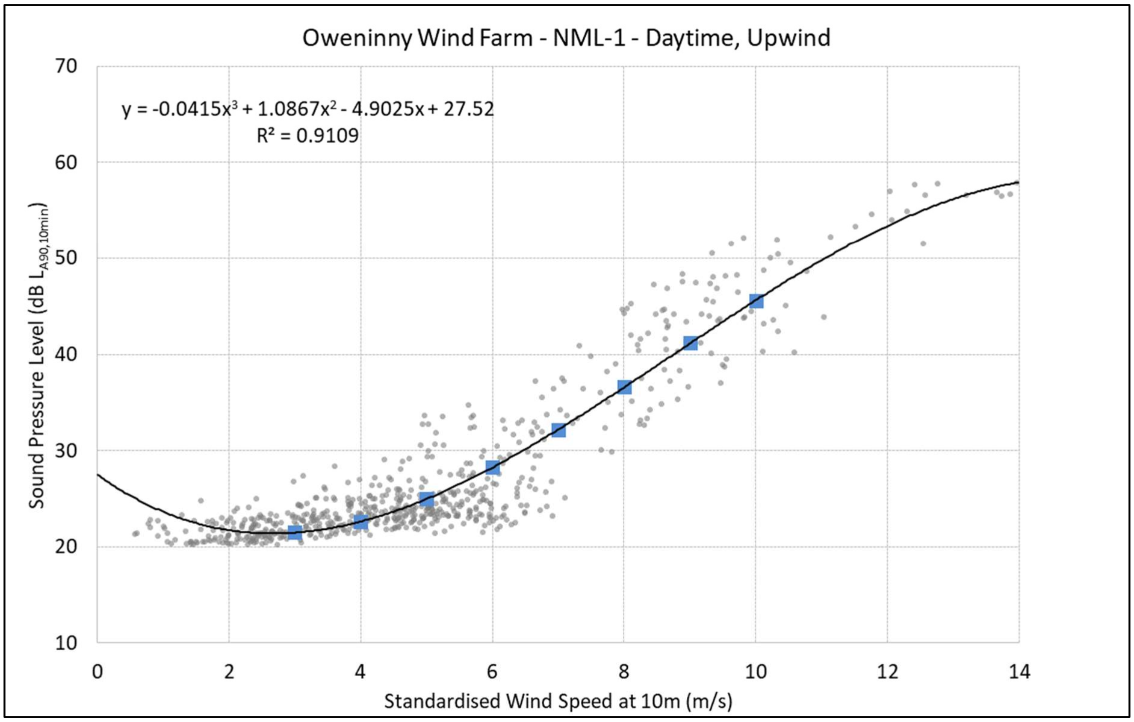

Figure 13.12 NML1 – Background Noise – Daytime Period – 121 m Hub Height

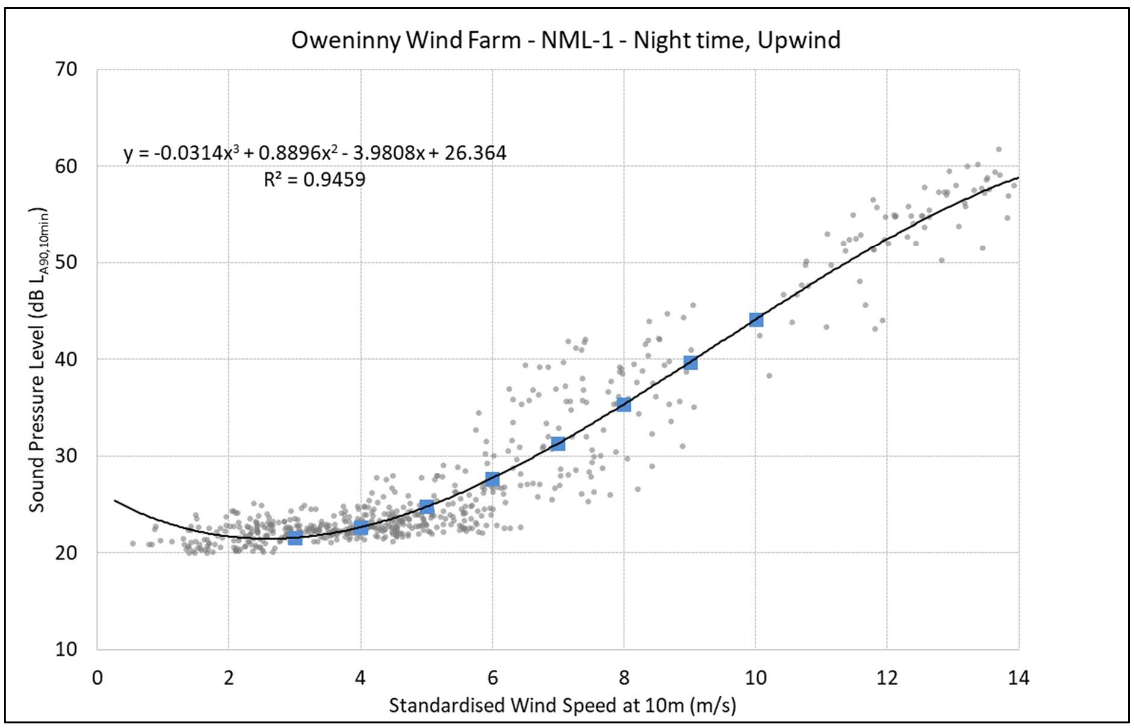

Figure 13.13 NML1 – Background Noise – Night-time Period – 121 m Hub Height

13.3.1.2 NML2

NML2 is situated to the east of existing turbines. For daytime and night time periods, the data has been filtered to include only wind directions between 20 and 200 degrees, which represents upwind conditions from operational turbines. The resulting background noise levels are presented in Table 13-11.

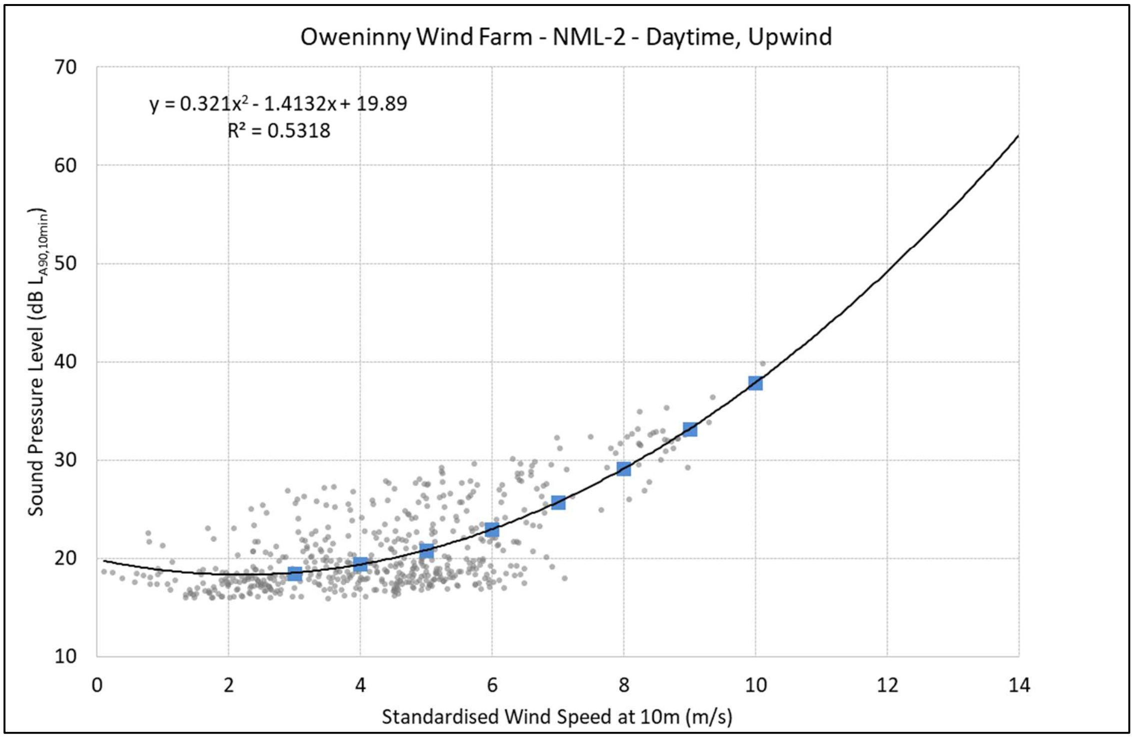

Figure 13.14 NML2 – Background Noise – Daytime Period – 121 m Hub Height

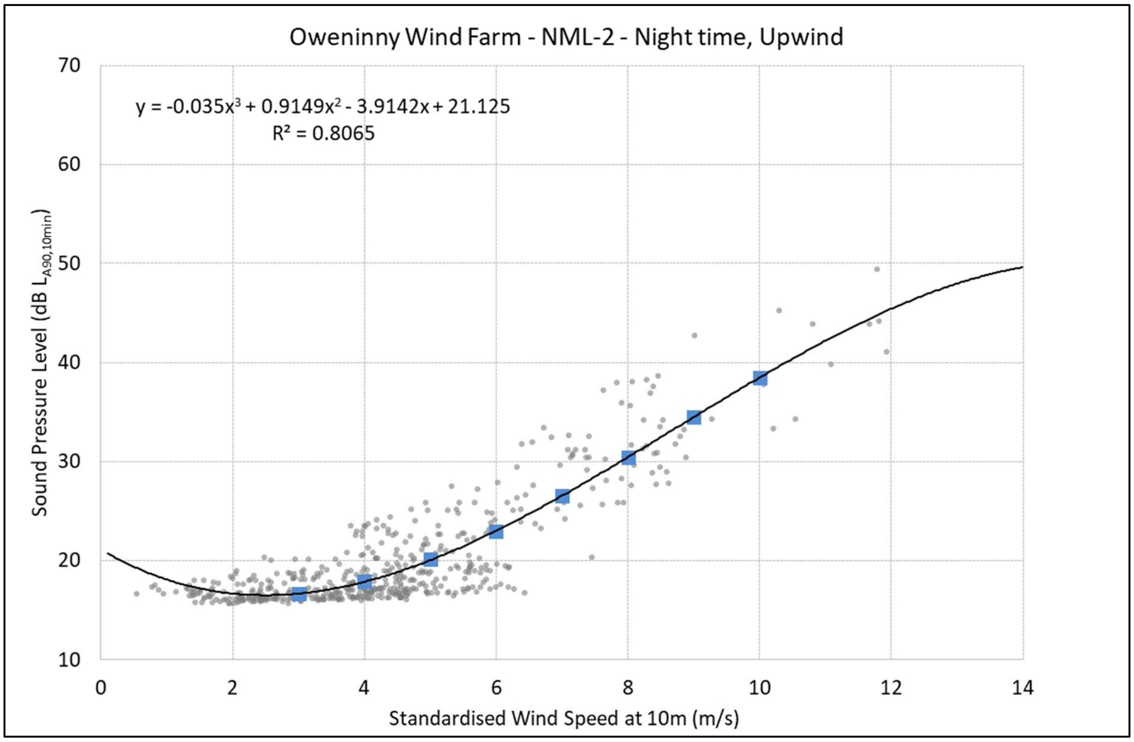

Figure 13.15 NML2 – Background Noise – Night-time Period – 121 m Hub Height

13.3.1.3 NML3

NML3 is situated to the south east of existing turbines. For daytime and night time periods, the data has been filtered to include only wind directions between 45 and 225 degrees, which represents upwind conditions from operational turbines. The resulting background noise levels are presented in Table 13-11.

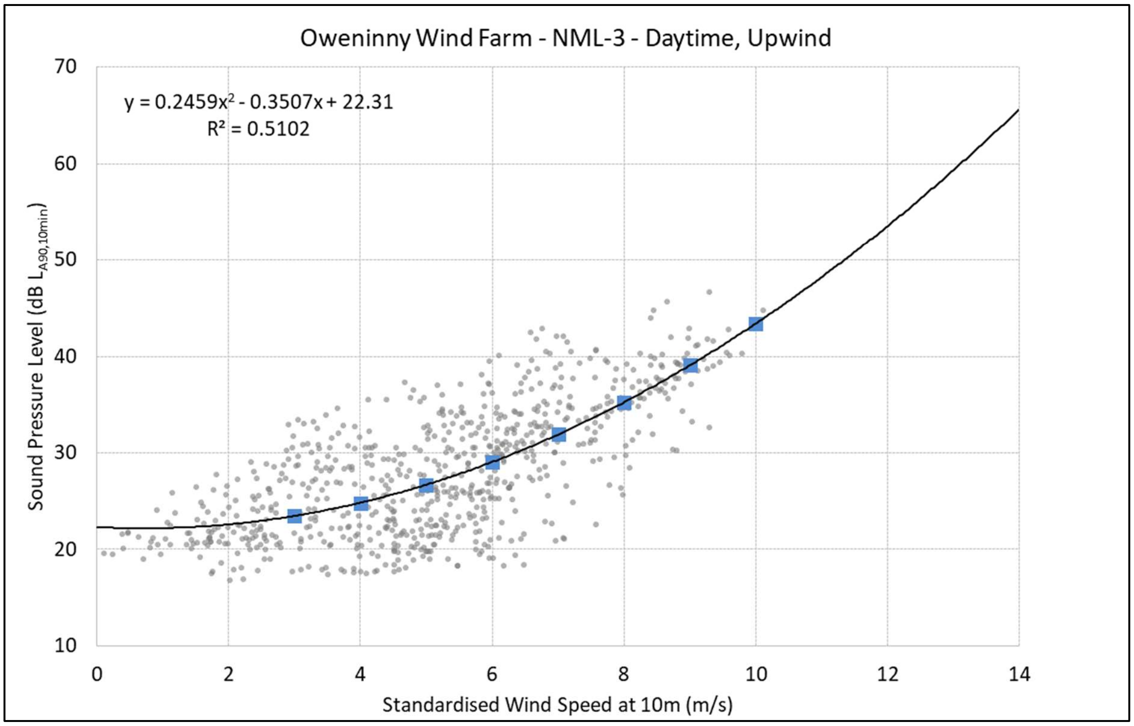

Figure 13.16 NML3 – Background Noise – Daytime Period – 121 m Hub Height

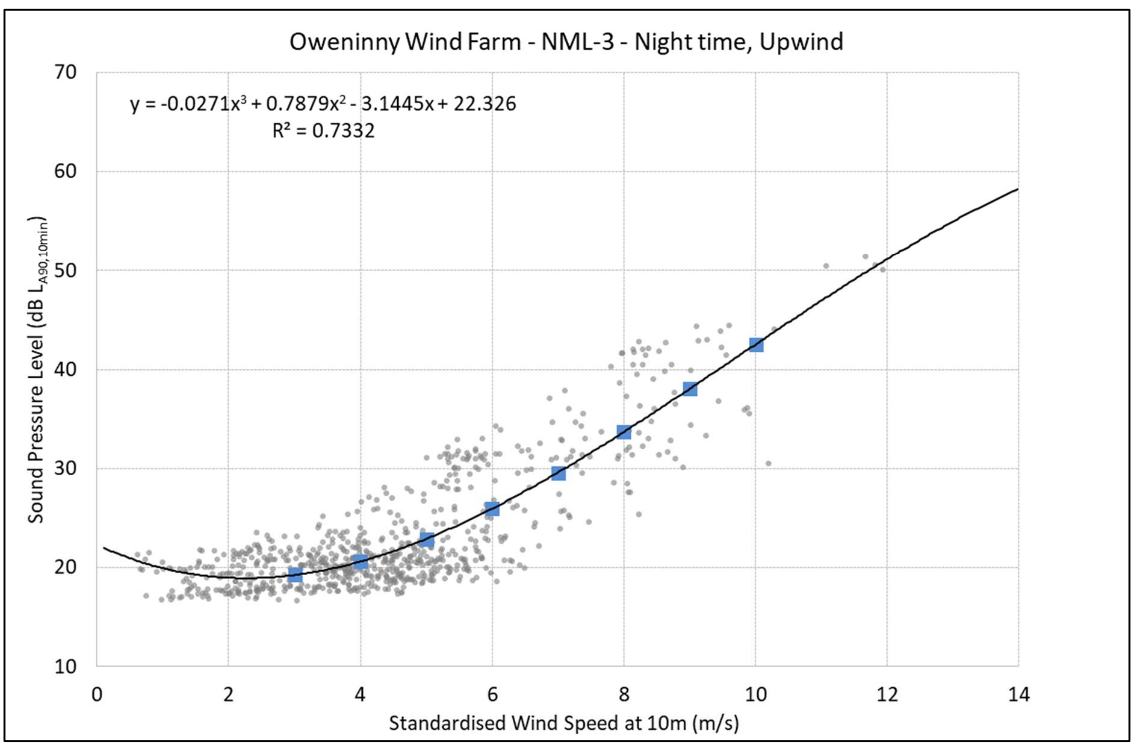

Figure 13.17 NML3 – Background Noise – Night-time Period – 121 m Hub Height

13.3.1.4 NML4

NML4 is situated to the south east of existing turbines. For daytime and night time periods, the data has been filtered to include only wind directions between 45 and 260 degrees, which represents upwind conditions from operational turbines. The resulting background noise levels are presented in Table 13-11.

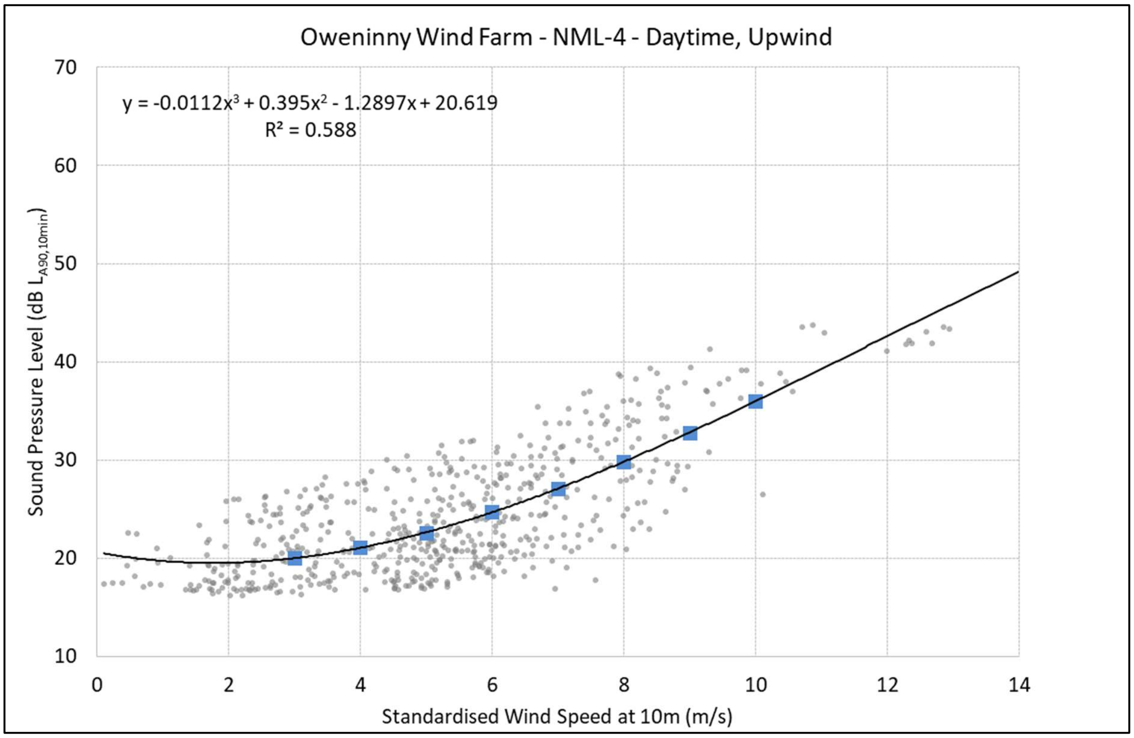

Figure 13.18 NML4 – Background Noise – Daytime Period – 121 m Hub Height

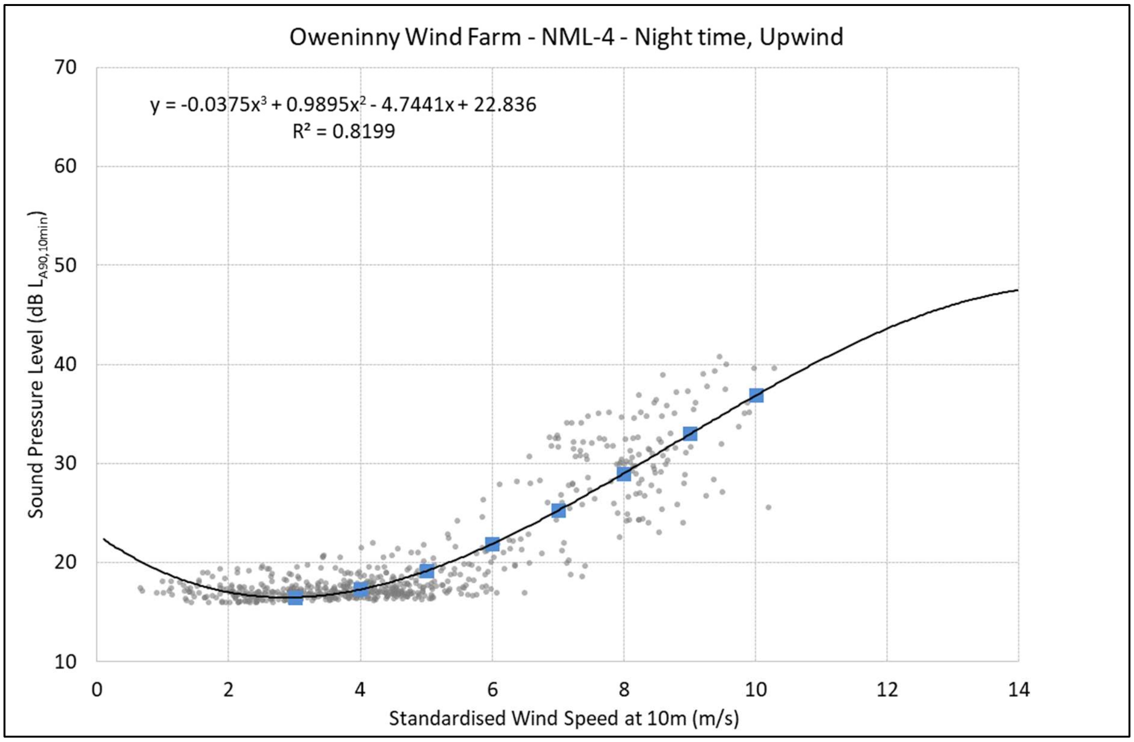

Figure 13.19 NML4 – Background Noise – Night-time Period – 121 m Hub Height

13.3.1.5 NML5

Due to the proximity of NML5 to the existing turbines at Oweninny Phase 1 and Bellacorick the measured upwind noise levels potentially include a contribution from the operational turbines. The predicted turbine noise levels at NML5 from existing turbines were typically within 3 dB of the measured levels, in these situations it is not possible to accurately determine the background noise levels by logarithmically subtracting the predicted contribution from the turbines from the measured levels. Therefore, the measured noise levels in the upwind conditions have been used to establish the typical background noise levels at NML5.

NML5 is situated to the south west of existing turbines. For daytime and night time periods, the data has been filtered to include only wind directions between 170 and 340 degrees, which represents upwind conditions from operational turbines. The resulting background noise levels are presented in Table 13-11.

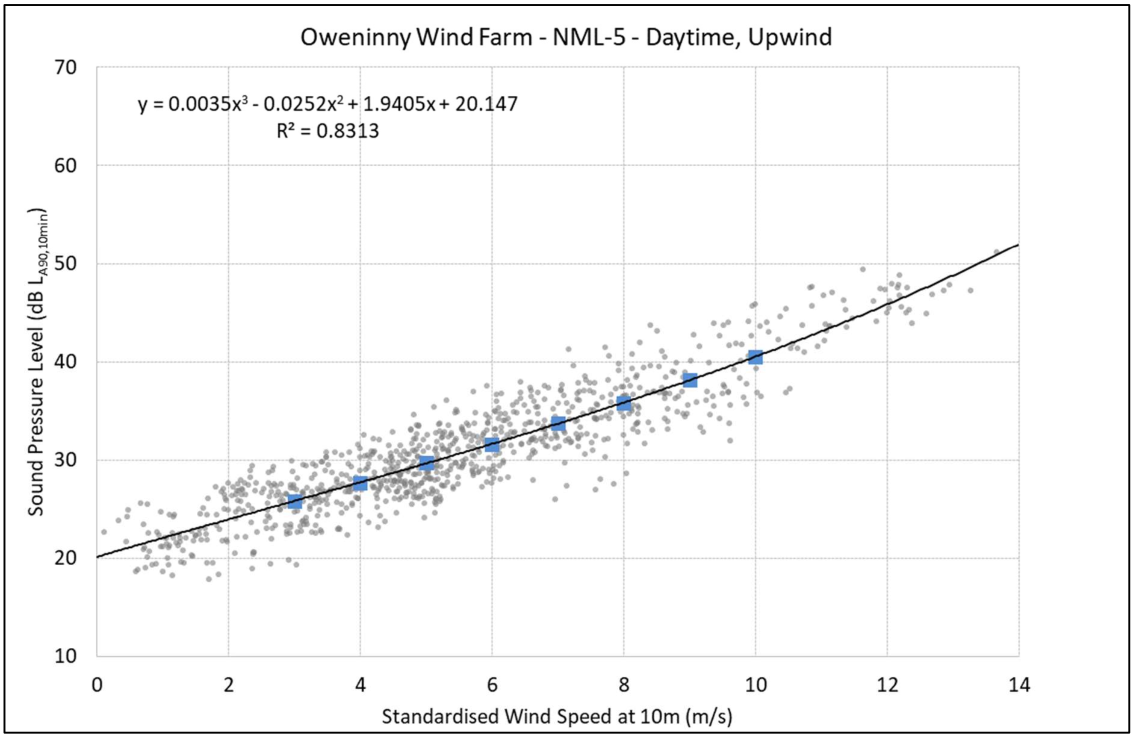

Figure 13.20 NML5 – Background Noise – Daytime Period – 121 m Hub Height

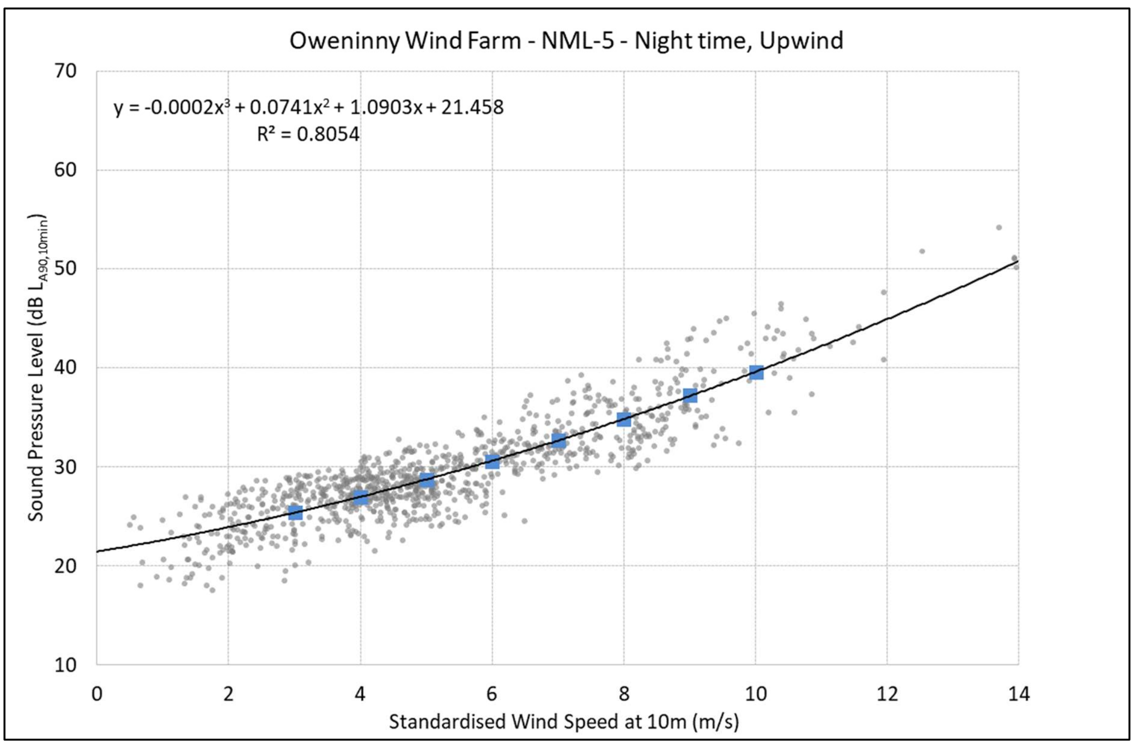

Figure 13.21 NML5 – Background Noise – Night-time Period – 121 m Hub Height

13.3.1.6 NML6

Due to the proximity of NML6 to the existing turbines at Oweninny Phase 1 and Bellacorick the measured upwind noise levels potentially include a contribution from the operational turbines. The predicted turbine noise levels at NML6 from existing turbines were typically within 3 dB of the measured levels , in these situations it is not possible to accurately determine the background noise levels by logarithmically subtracting the predicted contribution from the turbines from the measured levels. Therefore, the measured noise levels in the upwind conditions have been used to establish the typical background noise levels at NML6.

NML6 is situated to the west of existing turbines. For daytime and night time periods, the data has been filtered to include only wind directions between 180 and 350 degrees, which represents upwind conditions from operational turbines. The resulting background noise levels are presented in Table 13-11.

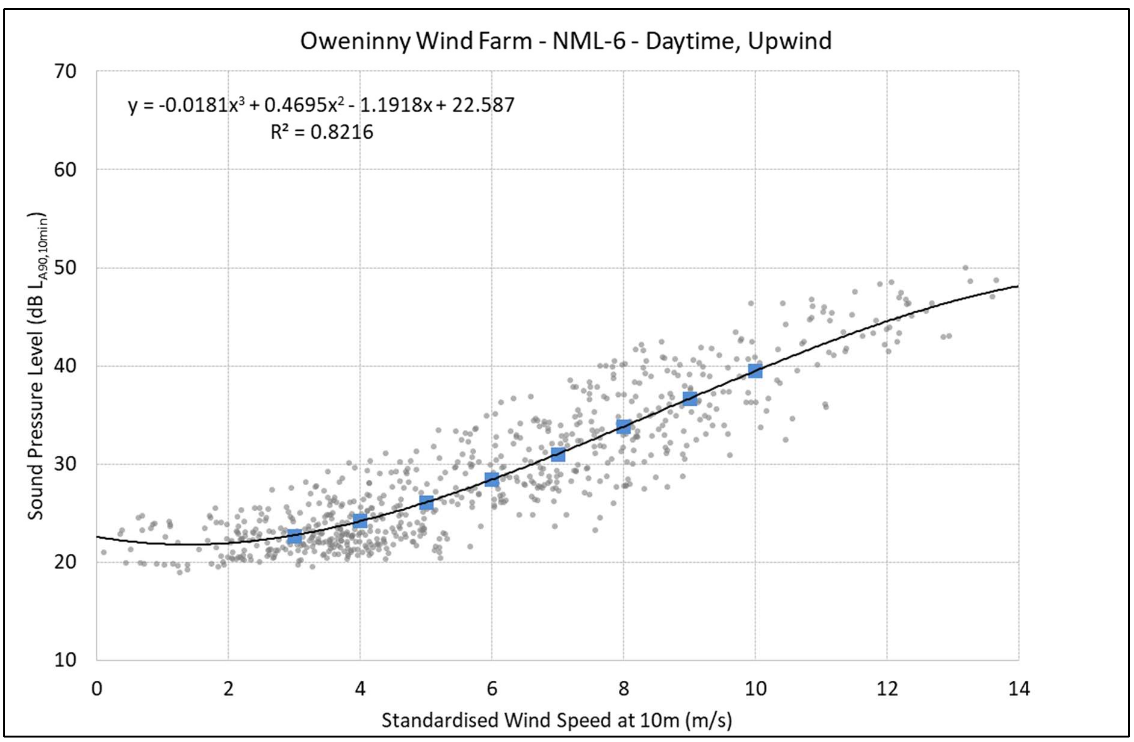

Figure 13.22 NML6 – Background Noise – Daytime Period – 121 m Hub Height

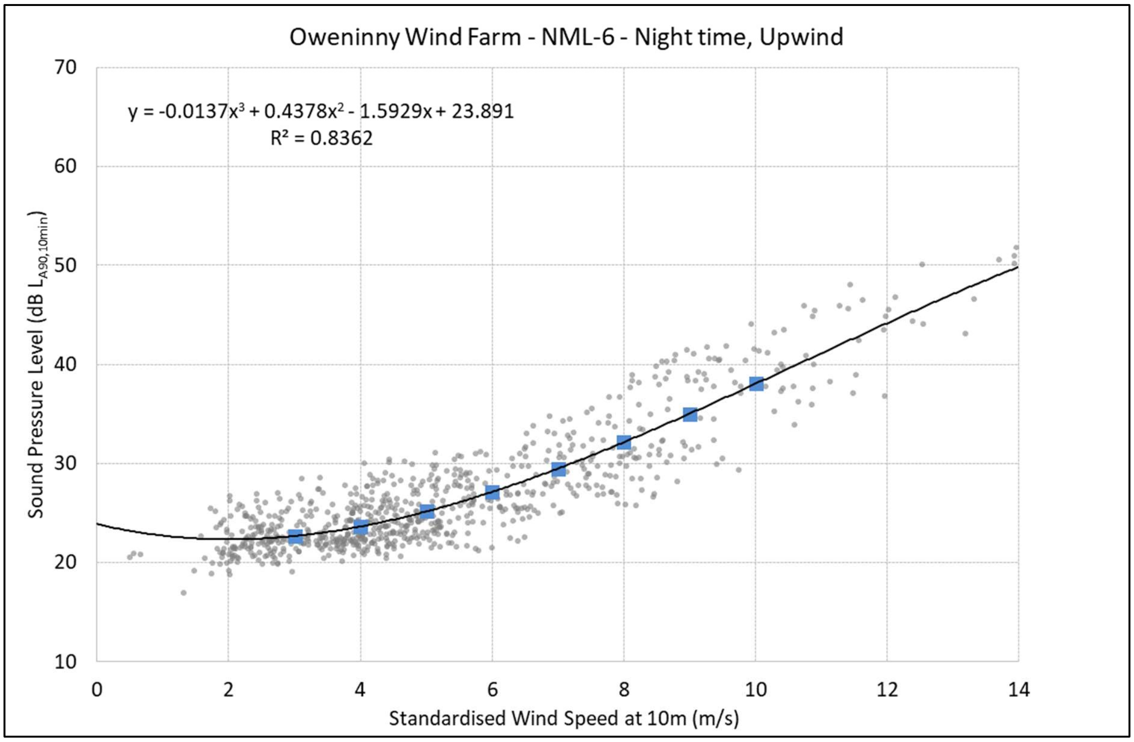

Figure 13.23 NML6 – Background Noise – Night-time Period – 121 m Hub Height

13.3.1.7 Summary

Table 13-11 presents the various derived $L_{A90,10min}$ noise levels for each of the monitoring locations for daytime quiet periods and night time periods. These levels have been derived using regression analysis carried out on the data sets in line with best practice guidance contained the IOA GPG and its SGN No. 2 *Data Collection.*

Table 13-11 Derived Levels of LA90,10-min for Various Wind Speeds

Location	Period	Derived $L_{A90,\ 10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	9
NML1	Day	21.5	22.6	25.0	28.3	32.2	36.6	41.2
	Night	21.6	22.7	24.8	27.7	31.3	35.4	39.7
NML2	Day	18.5	19.4	20.8	23.0	25.7	29.1	33.2
	Night	16.7	17.9	20.1	23.0	26.5	30.4	34.5
NML3	Day	23.5	24.8	26.7	29.1	31.9	35.2	39.1
	Night	19.3	20.6	22.9	26.0	29.6	33.7	38.1
NML4	Day	20.0	21.1	22.6	24.7	27.1	29.8	32.8
	Night	16.5	17.3	19.2	21.9	25.3	29.0	33.0
NML5	Day	25.8	27.7	29.7	31.6	33.7	35.8	38.1
	Night	25.4	27.0	28.7	30.6	32.7	34.8	37.2
NML6	Day	22.7	24.2	26.1	28.4	31.0	33.8	36.7
	Night	22.7	23.6	25.2	27.1	29.5	32.2	35.0

It is noted that the baseline noise survey was carried out during a period of restrictions of movement due to the COVID-19 pandemic, and that traffic movements and hence noise levels may have been lower than usual. The potential effect of this is that the background and baseline noise levels would be lower than normal, which results in the noise assessment being slightly conservative. Wind-generated noise in foliage surrounding the measurement equipment and noise-sensitive locations would have been representative of conditions at the survey locations.

The Oweninny Wind Farm Phase 2 which was not constructed at the time of the background noise survey has now been commissioned and is operational. As previously stated, the contribution to background noise levels of noise from an existing wind farm must be excluded when assigning background noise and setting noise limits for a new development. The background noise levels derived and presented in Table 13-11 remain valid.

13.3.1.8 Wind Turbine Noise Limits

With respect to the relevant guidance documents outlined in Section 13.2.2.4, noise criteria curves have been identified for the proposed development. The criteria curves have been derived following a detailed review of the background noise data conducted at the nearest NSLs.

This set of criteria has been chosen is in line with the intent of the relevant Irish guidance and best practice guidance, it is comparable to noise planning conditions applied to similar sites previously granted planning permission by An Bord Pleanála and local planning authorities in Ireland. For the Proposed Development, it is considered that a lower daytime threshold of 40 dB $L_{A90,10\text{-}min}$ for low noise environments where the background noise is less than 30 dB(A) would be appropriate in respect of the following points:

- The EPA document '*Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)*' proposes a daytime noise criterion of 45 dB(A) in 'areas of low background noise'. Turbine noise limits are detailed in terms of the L_{A90} parameter while the NG4 daytime limit is detailed in terms of the L_{Aeq}. The accepted difference between the L_{Aeq} and L_{A90} for wind turbine noise assessments is 2 dB, i.e., 45 dB L_{Aeq} equates to 43 L_{A90}. This approach infers a 3 dB difference when accounting for difference parameters between the NG4 limits and the WEDG06 limits. The proposed lower threshold criterion for wind turbine noise here is 3 dB more stringent than the equivalent daytime noise limit for areas of low background noise outlined in NG4.
- Recent planning condition issued by Mayo County Council (Planning Ref P20/467 imposed an effective lower threshold of 43 dB $L_{A90,T.}$ The proposed lower threshold here is more than 3 dB more stringent than this level.
- A lower threshold of 40 or 43 dB is commonly adopted in planning conditions for similar developments that have been granted planning permission by ABP and local planning authorities in recent years for example, Derrinlough Wind Farm (ABP Ref: 306706-20) Derryadd Wind Farm (ABP Ref: PL14.303592), Coole Wind Farm (ABP Ref: PL25M.300686) Cloncreen (ABP Ref: PA0047) and Meenbog (ABP Ref: PL05E.300460).

Notwithstanding the above discussion, as previously discuss in Section 13.2.2.4, the planning condition for Oweninny Wind Farm Phase 1 and Phase 2 and the accompanying EIS has set a lower daytime threshold of 37.5 dB $L_{A90,T}$ when background noise levels are less than 30 dB and daytime threshold of 43 dB $L_{A90,T}$ or 5 dB above background noise level, whichever is the greater. These limits set a precedence for the receiving environment and will be adopted for the proposed development as they represent the most onerous criteria identified in the review.

For noise sensitive locations where the turbine noise is predominantly from the operation of the Oweninny Wind Farm Phase 1 and Phase 2 developments, the conditioned limits imposed by the planning condition and the EIS are applicable and will be applied in this assessment. At all other noise sensitive locations, the proposed criteria are outlined below will be applied. The proposed turbine noise limits are cumulative and relate to noise from the contribution of all operational wind turbines.

In summary, the operational noise limits proposed for the development are:

- 37.5 dB $L_{A90,10min}$ for daytime in quiet environments with typical background noise of less than 30 dB $L_{A90,10min.}$
- 43 dB $L_{A90,10min}$ for daytime in environments with typical background noise greater than or equal to 30 dB $L_{A90,10min}$ or a maximum increase of 5 dB(A) above background noise (whichever is the higher); and
- 43 dB $L_{A90,10min}$ for night-time periods or a maximum increase of 5 dB(A) above background noise (whichever is the higher).

Day and night time noise criteria curves have been determined and are presented in the relevant sections of this Chapter. Table *13-12* outlines the operational noise criteria that are applicable to this assessment.

Table 13-12 Proposed Noise Criteria Curves

Location	Period	Turbine Noise limits $L_{A90,\ 10\text{-}min}$ Levels (dB) at Various Standardised 10 m Height Wind Speeds						
		3	4	5	6	7	8	9
NML1 (R07)	Day	37.5	37.5	37.5	37.5	43.0	43.0	46.2
	Night	43.0	43.0	43.0	43.0	43.0	43.0	44.7
NML2 (R10)	Day	37.5	37.5	37.5	37.5	37.5	37.5	43.0

	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML3 (R16)	Day	37.5	37.5	37.5	37.5	43.0	43.0	44.1
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.1
NML4 (R44)	Day	37.5	37.5	37.5	37.5	37.5	37.5	43.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
R73 NOTE 1	Day	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
R74 NOTE 1	Day	37.5	37.5	37.5	43.0	43.0	43.0	43.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0

NOTE 1: Noise criteria based on existing turbine noise limits condition at these locations (see Section 13.2.2.4).

Assigning Turbine Noise Limits

The derived turbine noise limits have been assigned to other NSLs which are deemed to be representative of the background noise levels at the nearby measurement locations. Where background noise measurements have been conducted in the vicinity and/or are judged to be typical/indicative of the background noise levels, these have been assigned to the other locations. As previously stated, locations in the vicinity of Oweninny Phase 1 and Phase 2 wind farms have specific turbine noise limits in place through the relevant planning condition(s) associated with these developments.

Table 13-13 confirms where representative background noise levels have been assigned to each of the relevant NSL's for the purpose of setting noise limits or where the existing noise conditions for turbine noise are in place for existing and permitted developments. Assigned the noise limits is based on professional judgement in line with best practice guidance of representative background noise levels that were measured as part of the survey. The representative locations are illustrated in Figure 13.24.

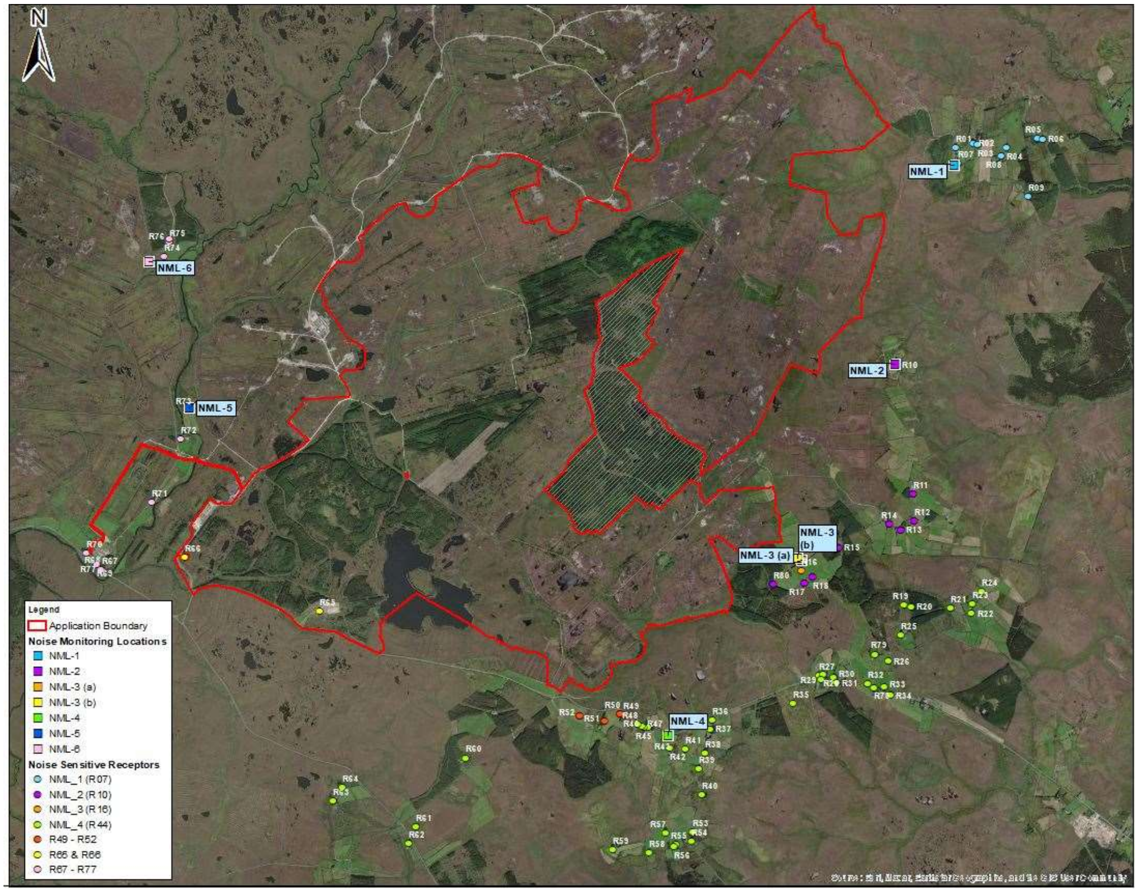

Figure 13.24 NSL locations

Table 13-13 Assignment of Turbine Noise Limits

Location	Turbine Noise Limits	Assigning Limits
NML1 (R07)	Derived from measured background noise levels	R01 – R06, R08 & R09
NML2 (R10)		R11 – R15, R17 – R18 & R80
NML3 (R16)		--
NML4 (R44)		R19 – R48, R53 – R64, R78 & R79
R67 – R77	Existing noise condition for Oweninny P1 & P2	Turbine noise limits taken from Table 7-15 of 2013 Environmental Impact Statement (EIS) in accordance with Condition 7(i) & 7(ii).
R49 – R52	Existing noise condition for Dooleeg More	Turbine noise Limits from Condition 11 of the Grant of Planning.
R65 & R66	n/a	No limits applicable as these are commercial properties that are not noise sensitive.

13.4 POTENTIAL EFFECTS

13.4.1 Do Nothing Effects

If the development is not progressed, the existing noise environment will remain largely unchanged. Traffic noise is currently a noise source in the vicinity of some road networks in the area. In the absence of the proposed development increases in traffic volumes on the local road network would be expected over time and would likely result in slight increases in the overall ambient and background noise levels in the area. Existing turbine noise in the environment would remain unchanged, if the permitted wind turbine developments are commissioned this will result in a increase in wind turbine noise at some noise sensitive locations.

13.4.2 Potential Effects – Construction Phase

Construction noise prediction calculations have been conducted using the methodology outlined in Section 13.2.2.1. The noise levels referred to in this section are indicative only and are intended to demonstrate that it will be possible for the contractor to comply with current best practice guidance. The predicted "worst case" levels are expected to occur for only short periods of time at a very limited number of properties. Construction noise levels will be lower than these levels for most of the time at most properties in the vicinity of the proposed development.

There are several stages and elements associated with the construction phase of the Proposed Development which will include the following:

- Decommissioning of Bellacorick wind turbines.
- Construction of turbines and hardstand areas.
- Construction of substation
- Cabling and grid connections.
- Operation of borrow pits.
- Internal roads.

Detailed information is included in Chapter 3: Description of the Proposed Development.

In general, the distances between the construction activities associated with the Proposed Development and the nearest NSL's are such that there will be no significant noise and vibration impacts at NSL's. The following sections present an assessment of the main stages of the construction phase that have the potential for associated noise and vibration impacts, all other stages and element are considered not to have significant noise and vibration impacts at NSL's.

Construction activities will be carried out during normal daytime working hours (i.e., weekdays 0700 – 1800hrs and Saturdays 0700 – 1400hrs). However, to ensure that optimal use is made of good weather period or at critical periods within the programme (e.g., concrete pours) or to accommodate delivery of large turbine component along public routes it could be necessary on occasion to work outside of these hours. Any such out of hours working will be agreed in advance with the Local Authority.

13.4.2.1 General Construction – Turbines and Hardstands

Noise

Several noise sources that would be expected on a construction site of this nature have been identified and predictions of the potential noise emissions calculated at the closest sensitive receptor. In this instance the closest noise sensitive receptor is Location R10, which is situated in excess of 1,160 m from the proposed turbine T16.

Table 13-14 outlines the typical construction noise levels associated with the proposed works for this element of the construction. Calculations have assumed an on-time of 66% for each item of plant i.e., that the item is operational for 8 hours over a 12-hour assessment period.

Table 13-14 Typical Wind Farm Turbine Construction Noise Emission Levels

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[8]	Predicted Noise Level (dB $L_{Aeq,T}$) at distance (m)
			1,000
HGV Movement (C.2.30)	Removing spoil and transporting fill and other materials.	79	31
Tracked Excavator (C.4.64)	Removing soil and rubble in preparation for foundation.	77	37

8 All plant noise levels are derived from BS5228: Part 1

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[8]	Predicted Noise Level (dB $L_{Aeq,T}$) at distance (m)
			1,000
Excavator Mounted Rock Breaker (C9.12)	Rock Breaking.	85	41
Piling Operations (C.12.14)	Piling Foundations (if required).	89	36
General Construction (Various)	All general activities plus deliveries of materials and plant	78	27
Dewatering Pumps (D.7.70)	If required.	80	28
JCB (D.8.13)	For services, drainage and landscaping.	82	29
Vibrating Rollers (D.8.29)	Road surfacing.	77	32
Total		--	45

At 1,000 m from the works the predicted noise levels from construction activities are in the range of 27 to 41 dB $L_{Aeq,T}$ with a total worst-case cumulative construction level of the order of 45 dB $L_{Aeq,T}$. In all instances the predicted noise levels at the nearest NSLs are below the appropriate criteria outlined in Table 13-1 (Category A – 65 dB $L_{Aeq,T}$ during daytime periods). This assessment is considered representative of worst-case construction noise levels at NSLs.

There is no item of plant that would be expected to give rise to noise levels that would be considered out of the ordinary or in exceedance of the levels outlined in Table 13-1 and this finding is valid should all items of plant operate simultaneously.

Vibration

Due to the distance of the proposed works from sensitive locations significant vibration effects are not expected.

Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with construction of turbines and hardstanding areas are described below.

Quality	*Significance*	*Duration*
Negative	Not significant	Temporary

The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.4.2.2 Decommissioning of Bellacorick Wind Turbines

Noise

Criteria for decommissioning noise are the same those presented in Section 13.2.2.1 and 13.2.2.2. The noise and vibration impacts associated with the decommissioning of the Bellacorick Turbines are expected to be less than those outlined in relation to the construction of the turbine and hardstands of the Proposed Development outlined in the preceding sections. The nearest NSLs to the Bellacorick Turbines is R73 at approximately 1,000 m. Assuming the same construction activities presented in Table 13-14, at 1,000 m from the works the predicted noise levels from construction activities are in the range of 27 to 41 dB $L_{Aeq,T}$ with a total worst-case cumulative construction level of the order of 45 dB $L_{Aeq,T}$. In all instances the predicted noise levels at the nearest NSLs are below the appropriate criteria outlined in Table 13-1 (Category A – 65 dB $L_{Aeq,T}$ during daytime periods). This assessment is considered representative of worst-case construction noise levels at NSLs.

There is no item of plant that would be expected to give rise to noise levels that would be considered out of the ordinary or in exceedance of the levels outlined in Table 13-1.

Vibration

Due to the distance of the proposed works from sensitive locations significant vibration effects are not expected.

Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with decommissioning of Bellacorick wind turbines are described below.

Quality	*Significance*	*Duration*
Negative	Not significant	Temporary

The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.4.2.3 Construction of Internal Site Roads

It is proposed to construct new internal roads to access the various parts of the development. Review of the track layout has identified that the nearest NSL to any point along the proposed track is 450 m to R71. All other locations are at greater distances with the majority at significantly greater distances. The full description of the new road is outlined in Chapter 3 of the EIAR, *Description of the Proposed Development*.

Noise

Table 13-15 outlines the typical construction noise levels associated with the proposed works for this element of the construction. Calculations have assumed an on-time of 66% for each item of plant i.e., that the item is operational for 8 hours over a 12-hour assessment period.

Table 13-15 Indicative Noise Levels from Construction Plant at Various Distances from the New Internal Access Track Works

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[9]	Highest Predicted Noise Level at Stated Distance from Edge of Works(dB $L_{Aeq,T}$)
		450 m
HGV (C.2.30)	79	34

[9] All plant noise levels are derived from BS5228: Part 1

Excavator Mounted Rock Breaker (C9.12)	85	40
Vibration Rollers (D.8.29)	77	32
Total	--	41

The table shows that at 450 m, noise levels are well within the construction noise criteria in Table 13-1 and therefore the impact is not significant. As these works will progress along the route the worst-case predicted impacts will reduce.

There are no items of plant or construction activities that would be expected to give rise to noise levels that would be considered out of the ordinary or in exceedance of the levels outlined in Table 13.1 It is concluded that while there may be significant noise impacts predicted at some noise-sensitive locations nearest the internal access tracks, and therefore no specific mitigation measures are required.

Vibration

Due to the distance of the proposed works from sensitive locations significant vibration effects are not expected.

Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with construction of internal site roads are described below.

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.4.2.4 Amenity Walkway

It is proposed to upgrade and maintain an existing internal site road and repurpose it as a new amenity only walkway within the site. The full description of the repurposed walkway is outlined in Chapter 3 of the EIAR, *Description of the Proposed Development*. Review of the track layout has identified that the nearest NSL to any point along the proposed track is 420 m to R52. All other locations are at greater distances with the majority at significantly greater distances.

Noise

Table 13-16 outlines the typical construction noise levels associated with the proposed works for this element of the construction. Calculations have assumed an on-time of 66% for each item of plant i.e., that the item is operational for 8 hours over a 12-hour assessment period. Note the plant items and activities are indicative and based on conservative assumption to represent a worst case.

Table 13-16 Indicative Noise Levels from Construction Plant at Various Distances from the Amenity Walkway Works

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[10]	Highest Predicted Noise Level at Stated Distance from Edge of Works(dB $L_{Aeq,T}$)
		420 m
HGV (C.2.30)	79	35
Excavator Mounted Rock Breaker (C9.12)	85	41
Vibration Rollers (D.8.29)	77	33
Total	--	42

The table shows that at 420 m, noise levels are well within the construction noise criteria in Table 13-1 and therefore the impact is not significant. As these works will progress along the route the worst-case predicted impacts will reduce.

10 All plant noise levels are derived from BS5228: Part 1

There are no items of plant or construction activities that would be expected to give rise to noise levels that would be considered out of the ordinary or in exceedance of the levels outlined in Table 13.1 It is concluded that while there may be significant noise impacts predicted at some noise-sensitive locations nearest the amenity walkway, and therefore no specific mitigation measures are required.

Vibration

Due to the distance of the proposed works from sensitive locations significant vibration effects are not expected.

Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with construction of amenity walkways are described below.

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.4.2.5 Borrow Pits

To inform this aspect of the proposal, a noise assessment has been based on the following assumptions:

- A mobile crusher will operate on site.
- Two rock breakers will be in use on site during daytime periods.
- The plant is operating simultaneously in the vicinity of all proposed borrow pit locations indicated in Table 13-17.

- Table 13-17 outlines the assumed noise levels for the plant items as extracted from BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.

Table *13-18*

Table 13-17 Proposed Borrow Pit Locations

Borrow Pit Ref	Co-ordinates (ITM)	
	Easting	Northing
A	503,445	822,902
B	500,893	823,288

Table 13-18 Plant Noise Emissions

Item	BS 5228 Ref.	dB L_w Levels per Octave Band (Hz)								dB(A)
		63	125	250	500	1k	2k	4k	8k	
Crusher	C1.14	121	114	107	109	103	99	94	87	110
Rock Breaker	C9.11	119	117	113	117	115	115	112	108	121

A construction noise model has been prepared to consider the expected noise emissions from the proposed construction works at borrow pits as outlined above. A percentage on-time of 66% has been assumed for the noise calculations. The predicted levels at the 10 no. NSL's, with the highest predicted noise levels is presented in Table 13-19.

Table 13-19 Prediction Noise Levels from Borrow Pit Activity at Nearest NSLs

Location Ref.	$L_{Aeq,T}$
R10	39
R07	34
R01	34
R15	33
R11	33
R16	33
R80	33
R02	33
R03	33

R14	33

Review of the results contained in Table 13-19.confirms that the predicted construction noise levels are well within the relevant construction noise criteria (65 dB $L_{Aeq,T}$). It is assumed that construction works at the borrow pit will only occur during daytime periods only.

Vibration

Due to the distance from the proposed works to NSLs, and the duration of any potential impact on any single dwelling significant vibration effects are not expected.

Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest NSLs associated with the operation of borrow pits are described below.

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.4.2.6 Substation Construction

Noise

The substation is to be located at coordinates E500072 N821065. The nearest NSL to the proposed substation IS R72 at a distance greater than 2 km to the west. As a worst-case example assuming the same construction activities as outlined in Table 13-14, it is predicted that the likely worst-case potential noise levels from construction activities associated with the substation will be in the order of 30 dB $L_{Aeq,T}$ at the nearest NSL. This level of noise is well within the construction noise criterion outlined in Table 13-1.

Vibration

Due to the distance of the proposed works from sensitive locations significant vibration effects are not expected.

Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with construction of the substation are described below.

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.4.2.7 Grid Connection Construction

Noise

The proposed grid connection route is within the site boundary, an underground 110kV underground cable will run from the proposed onsite electrical substation to the existing substation at Bellacorick. The full description of the cable route is outlined in Chapter 3 of the EIAR, *Description of the Proposed Development*. Review of the cable layout has identified that the nearest NSL to any point along the proposed track is 40 m to R70. All other locations are at greater distances e.g., R69 at approximately 100 m, R72 at approximately 200 m and R71 at approximately 400 m.

Noise

Table 13-20 outlines the typical construction noise levels associated with the proposed works for this element of the construction. Calculations have assumed an on-time of 66% for each item of plant i.e., that the item is operational for 8 hours over a 12-hour assessment period. Note the plant items and activities are indicative and based on conservative assumption to represent a worst case.

Table 13-20 Indicative Noise Levels for Typical Construction Plant at Various Distances from the Grid Connection Works

Item (BS 5228 Ref.)	Highest Predicted Plant Noise Level (dB LAeq,T)				
	40m Distance	100m Distance	200m Distance	300m Distance	400m Distance
Tracked Excavator (C.2.5)	57	47	40	35	32
Hydraulic vibratory compactor (tracked excavator) (C.2.42)	59	49	42	37	34
Wheeled Loader (C.2.8)	49	39	32	27	24
HGV (C.6.19)	57	47	40	35	32
Total Construction Noise	63	53	45	41	38

At distances of 40m, the predicted cumulative noise levels from construction activities are 63 dB $L_{Aeq,T}$, which are below the significance threshold of 65 dB $L_{Aeq,1hr}$. Given the variations of grid connection activities, the number of plant items operating at any one time and the location of upgrading road works only operating along the closest boundaries for a limited duration of the overall development, the calculated noise levels presented are considered to present a worst-case scenario. As these works will progress along the route the worst-case predicted impacts will reduce.

At the noise-sensitive receptors set back at further distances from the works, the predicted noise levels are in the order of 53 dB $L_{Aeq,T}$ or below, which is below the significance threshold of 65 dB $L_{Aeq,1hr}$.

Vibration

Due to the distance from the proposed works to NSLs, and the duration of any potential impact on any single dwelling significant vibration effects are not expected.

Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified, the worst case predicted impact are predicted to be approaching the threshold of significant noise impact but are expected to be a 'brief' duration. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest NSLs associated with the construction of the grid connection are described below.

Quality	*Significance*	*Duration*
Negative	Moderate	Temporary

The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.4.2.8 Construction Traffic

This section of the report has been prepared in order to review potential noise impacts associated with construction traffic on the local road network. Chapter 17 of this EIAR presents an assessment of traffic and transportation and reference has been made to this chapter to inform the following discussion. This assessment focuses on the predicted increases in road traffic noise along the construction haul route (N59),

Changes in traffic noise levels associated with the additional construction traffic have been calculated for the peak construction period and average construction period. Table 13-21 presents a summary of the data on which the calculations have been based.

Table 13-21 Information for Construction Traffic Noise Assessment

Route	Scenario	Traffic Units (ADT)	%HGV
N59	Base Flow	2812	8.5
	Peak Construction	3095	13
	Average Construction	2977	11.6

Based on the data presented above the changes in noise level relative to the noise from existing traffic flows have been calculated and are outlined in Table 13-22.

Table 13-22 Estimated Changed to Traffic Noise Levels

Route	Stage	Change in Traffic Noise Level dB(A)	Duration
N59	Peak Construction	+2	3 months (Temporary)
	Average Construction	+1	21 months (Short Term)

The increase in noise levels due to additional construction traffic on each of the routes is predicted to be 2 dB for peak construction period and 1 dB for the average construction period most stages along the hauls route. With respect to the assessment criteria outlined in Section 13.2.2.3 the magnitude of this impact is minor.

Description of Effects

With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest NSLs associated with this aspect of the construction phase are described below.

Quality	*Significance*	*Duration*
Negative	Slight	Temporary

The above effects should be considered in terms that the effect is variable and that this assessment considers the locations of the greatest potential impact.

13.4.3 Potential Effects – Operational Phase

13.4.3.1 Assessment of Wind Turbine Noise

The predicted cumulative noise levels for the Proposed Development in combination with all other identified, constructed and permitted wind turbine development, has been calculated for all noise sensitive locations identified within the study area. The predicted noise levels for all noise sensitive locations with the potential for any significant cumulative turbine noise impacts has also been calculated.

A worst-case omni-directional assessment has been completed assuming all noise sensitive locations are downwind of all turbines at the same time (an impossible scenario) and noise predictions have been made using the ISO 9613-2 standard which represents worst-case conditions favourable to noise propagation (typically downwind propagation from source to receiver and/or downward refraction under temperature inversions).

The results of the noise prediction models have been compared against the turbine noise limits that have been assigned to each of the NSL's in accordance with the criteria set out in Section 13.3.1.8.

At all NSL's the worst omni-directional cumulative turbine noise levels are below the noise criterion curves which the exception of some slight exceedances at R74, R75 and R76. It should be noted that these potential exceedances are based on omni-directional noise prediction calculations which do not occur in real world scenarios.

Table 13-23 presents the omnidirectional predate cumulative turbine noise levels and the contribution from the proposed development at the locations with potential exceedances.

Table 13-23 Review of Cumulative Predicted Turbine Noise Levels against Relevant Criteria – NSLs with Potential exceedances.

House	Parameter	Derived $L_{A90, 10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	9
R74	Proposed Development	17.5	21.1	25.4	28.1	28.5	28.5	28.5
	Predicted (Cumulative)	30.1	32.7	37.4	41.6	42.7	43.2	43.4
	Daytime Criterion	37.5	37.5	37.5	43.0	43.0	43.0	43.0
	Daytime Excess	--	--	--	--	--	0.2	0.4
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	0.2	0.4
R75	Proposed Development	17.6	21.2	25.5	28.1	28.5	28.5	28.5
	Predicted (Cumulative)	29.9	32.5	37.3	41.5	42.5	43.1	43.3
	Daytime Criterion	37.5	37.5	37.5	43.0	43.0	43.0	43.0
	Daytime Excess	--	--	--	--	--	0.1	0.3
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	0.1	0.3
R76	Proposed Development	17.6	21.2	25.4	28.1	28.5	28.5	28.5
	Predicted (Cumulative)	29.9	32.5	37.3	41.5	42.5	43.1	43.2
	Daytime Criterion	37.5	37.5	37.5	43.0	43.0	43.0	43.0
	Daytime Excess	--	--	--	--	--	0.1	0.2
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	0.1	0.2

The levels of turbine noise at Locations R74, R75 & R76 from the Proposed Development are not significant as the contribution to the overall noise levels is greater than 10 dB below the overall level (see Section 13.2.2.4). The slight potential exceedances identified in the cumulative omnidirectional model relate to noise from other developments i.e., Oweninny Wind Farm Phase 1 and Phase 2.

Table 13-24 confirms the maximum predicted cumulative turbine noise levels for each of the wind direction sectors at locations R74, R75 & R76. The results of this exercise for all NSL's are presented in Appendix 13.4. Appendix 13.5 presents the predicted omni-directional results at all NSL's from the operation of the Proposed Development in isolation.

Table 13-24 Directional Cumulative Predicted Noise Levels at Maximum Turbine Noise Emission Level

NSL	LA90, 10-min Levels (dB) at Maximum Turbine Noise Emission Level at Various Wind Direction Sectors (9 m/s 10m Height Standardised Wind Speed)							
	N	NE	E	SE	S	SW	W	NW
R74	41.2	41.2	41.2	41.6	41.8	41.5	41.5	41.2
R75	41.2	41.1	41.2	41.5	41.6	41.4	41.2	41.0
R76	41.1	41.1	41.2	41.5	41.5	41.4	41.2	40.9

Noise contours for scenarios 1 and 2 for the omni-directional cumulative rated power wind speed (i.e., highest noise emission) for the cumulative scenario and the Proposed Development in isolation are presented in Appendix 13.6.

Consideration of Wind Direction

The preceding section considered omni-directional cumulative noise i.e., assuming all noise locations being downwind of all turbines at the same time. The next step in the assessment is to consider wind directionality and turbine noise propagation in the noise prediction model using the methods outlined in Section 13.2.3.3.

A full suite of directional noise prediction results for all NSL's at maximum turbine noise emission level is presented in Appendix 13.7.

It is noted following review of the directional noise predictions that the slight potential exceedances of the criteria noted in the omni-directional predictions at locations R74, R75 and R76 are no longer present. It is confirmed that the predicted cumulative turbine noise levels with the proposed development are all below the turbine noise criterion curves and specific noise mitigation measures are not required.

Taking the above into account, it is not considered that a significant effect is associated with the operation of this development, since the predicted noise levels associated with the proposed development will be within the relevant best practice noise criteria curves for wind farms.

While noise levels at low wind speeds will increase due to the Proposed Development the predicted levels will remain low, albeit a new source of noise will be introduced into the soundscape. Due to the distance of the turbine of the Proposed Development and the nearest NSLs, the level of turbine noise due to the Proposed Development is relatively low and well below the noise criterion curves identified.

Description of Effects

The likely predicted noise impacts are below the limits identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest NSLs associated with the operation of the wind farm is described below.

Quality	*Significance*	*Duration*
Negative	Slight	Long-term

The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.4.3.2 Substation Noise

Details of the proposed substation options are described in Chapter 3 of the EIAR (Description of the Proposed Development). The substation will typically be operational 24/7, and the noise impact at the nearest NSL has been assessed to identify the potential greatest impact associated with the operation of the Substation at the nearest NSL.

As part of the Proposed Development, the substation will be operational on a continuous basis. The noise emission level associated with a typical substation that would support a development of this nature is the order of 93 dB(A) Lw.

Noise prediction calculations for the operation of the 110kV substation have been undertaken in accordance with ISO 9613: Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation (1996). The predicted noise level from the operation of the substation at the nearest NSL (R72 at approximately 2.4 km) is 11 dB $L_{Aeq,T}$. This level of noise would be inaudible at the nearest NSL, and it is concluded that there will be no significant noise emissions from the operation of the substation at any NSL.

Description of Effects

The predicted noise levels are expected to be inaudible at the nearest NSL. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest NSLs associated with the operation of the proposed substation is described below.

Quality	*Significance*	*Duration*
Negative	Imperceptible	Long-term

13.4.4 Decommissioning Phase

In relation to the decommissioning phase, similar overall noise levels as those calculated for the construction phase would be expected, as similar tools and equipment will be used. See Section 13.4.2 for predicted noise levels. Considering that in all aspects of the construction and decommissioning, the predicted noise levels are expected to be below the appropriate Category A value (i.e. 65 dB $L_{Aeq,T}$) at all NSLs for the decommissioning phase, the impact is not significant.

13.5 MITIGATION MEASURES

The assessment of potential impacts has demonstrated that the proposed development is expected to comply with the identified criteria for both the construction and operational phases of the project. However, to ameliorate any potential noise and vibration impacts that may present during the construction and decommissioning, a schedule of noise control measures has been formulated.

13.5.1 Construction Phase

Regarding construction activities, reference shall be made to BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise, which offers detailed guidance on the control of noise and vibration from construction activities. It is proposed that various practices be adopted during construction as required, including the following:

- limiting the hours during which site activities likely to create high levels of noise or vibration are permitted.
- establishing channels of communication between the contractor/developer, Local Authority, and residents.
- appointing a site representative responsible for matters relating to noise and vibration.
- monitoring typical levels of noise and vibration during critical periods and at sensitive properties; and
- keeping the surface of the site access tracks even to mitigate the potential for vibration from lorries.

Furthermore, a variety of practicable noise control measures will be employed. These include:

- regular maintenance and servicing of machinery.
- selection of plant with low inherent potential for generation of noise and/ or vibration.
- placing of noisy / vibratory plant as far away from sensitive properties as permitted by site constraints.

13.5.1.1 Noise

The contract documents shall specify that the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures when deemed necessary to comply with the recommendations of BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*. The following list of measures will be implemented as required to ensure compliance with the relevant construction noise criteria:

- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors will be attenuated models, fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate before 07:00hrs or after 19:00hrs will be surrounded by an acoustic enclosure or portable screen.
- During the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Table 13. 13 using methods outlined in BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between :00hrs and 18:00hrs Mondays to Friday and 07:00hrs to 14:00hrs on Saturdays. However, to ensure that optimal use is made of good weather period or at critical periods within the programme (i.e., concrete pours) or to accommodate delivery of large turbine component along public routes it could be necessary on occasion to work outside of these hours.

Where rock breaking is employed, the following are examples of measures that will be implemented, to mitigate noise emissions from these activities:

- Fit suitably designed muffler or sound reduction equipment to the rock breaking tool to reduce noise without impairing machine efficiency.
- Ensure all leaks in air lines are sealed.

- Erect acoustic screen between compressor or generator and noise sensitive area. When possible, line of sight between top of machine and reception point needs to be obscured.
- Enclose breaker or rock drill in portable or fixed acoustic enclosure with suitable ventilation.

13.5.1.2 Vibration

Vibration from construction activities will be limited to the values set out in

Table *13-2*. It should be noted that these limits are not absolute but provide guidance as to magnitudes of vibration that are very unlikely to cause cosmetic damage. Magnitudes of vibration slightly greater than those in the table are normally unlikely to cause cosmetic damage, but construction work creating such magnitudes should proceed with caution. Where there is existing damage, these limits may need to be reduced by up to 50%.

Pilling activities may be required for construction of turbine foundations, based on the large distances between locations where piling would take place and the nearest NSLs, no significant impact will be experienced. Therefore, no mitigation measures are proposed.

13.5.2 Operational Phase

A cumulative assessment of the operational turbine noise levels has been undertaken in accordance with best practice guidelines and procedures as outlined in Section 13.2.2.4 of this Chapter. The turbine noise assessment has considered the cumulative noise impact of the Proposed Development in combination with Oweninny Phase 1 and Oweninny Phase 2 Wind Farms. A review of other wind turbine developments in accordance with the IOAGPG guidance has confirmed that the cumulative contribution of turbine noise from these sites could be screened from the cumulative assessment.

The findings of the assessment confirmed that the predicted operational noise levels from the Proposed Development in combination with all permitted and existing wind farms in the area, will be within the relevant best practice noise criteria. Therefore, no specific mitigation measures are required.

If alternative turbine technologies are considered for the Proposed Development an updated noise assessment will be prepared to confirm that the noise emissions will comply with the noise criteria as per best practice guidance outlined in Section 13.3.1.8**Error! Reference source not found.** and/or the relevant operational criteria associated with the grant of planning for existing/permitted developments. If necessary, suitable curtailment strategies will be designed and implemented for alternative technologies to ensure compliance with the relevant noise criteria, should detailed assessment conclude that this is necessary.

13.5.2.1 Amplitude Modulation

In the event that a complaint which indicates potential amplitude modulation (AM) associated with turbine operation, the operator will employ a qualified acoustic consultant to assess the level of AM in accordance with the methods outlined in the Institute of Acoustics (IOA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely, Institute of Acoustics IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group Final Report: A Method for Rating Amplitude Modulation in Wind Turbine Noise (9 August 2016) or subsequent revisions.

The measurement method outlined in the IOA AMWG document, known as the 'Reference Method', will provide a robust and reliable indicator of AM and yield important information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions including mitigation.

13.5.3 Decommissioning Phase

The mitigation measures that will be considered in relation to any decommissioning of the site are the same as those proposed for the construction phase of the development, i.e., as per Section 13.5.1.

13.5.4 Monitoring

Commissioning noise surveys will be undertaken to ensure compliance with any noise conditions applied to the development. In the unlikely instance that an exceedance of these noise criteria is identified, the assessment guidance outlined in the IOA GPG and Supplementary Guidance Note 5: Post Completion Measurements (July 2014) should be followed, and relevant corrective actions will be taken. For example, implementation of noise operational modes resulting in curtailment of turbine operation can be implemented for specific turbines in specific wind conditions to ensure predicted noise levels are within the relevant noise criterion curves/planning conditions. Such curtailment can be applied using the wind farm SCADA system without undue effect on the wind turbine.

13.6 RESIDUAL EFFECTS

This section summarises the likely residual noise and vibration effects associated with the proposed development following the implementation of mitigation measures.

13.6.1 Construction Phase

During the construction phase of the project there will be some effect on nearby NSLs due to noise emissions from site traffic and other construction activities. However, given the distances between the main construction works and nearby NSLs and the fact that the construction phase of the development is temporary in nature, it is expected that the various noise sources will not be excessively intrusive. Furthermore, the application of binding noise limits and hours of operation, along with implementation of appropriate noise and vibration control measures, will ensure that the noise and vibration effect is kept to a minimum.

With respect to the EPA's criteria for description of effects, in terms of these construction activities, the potential worst-case associated effects at the nearest NSLs associated with the various elements of the construction phase are described below.

13.6.1.1 General Construction – Turbines and Hardstands

Quality	*Significance*	*Duration*
Negative	Not significant	Temporary

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. The described effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.6.1.2 Decommissioning of Bellacorick Wind Turbines

Quality	*Significance*	*Duration*
Negative	Not significant	Temporary

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. The described effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.6.1.3 Construction of Internal Site Roads

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. The described effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.6.1.4 Construction of Amenity Walkways

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. The described effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.6.1.5 Borrow Pits

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.6.1.6 Substation Construction

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. The described effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.6.1.7 Grid Connection Construction

Quality	*Significance*	*Duration*
Negative	Moderate	Temporary

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified, the worst case predicted impact are predicted to be approaching the threshold of significant noise impact but are expected to be a ‘brief’ duration. The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.6.1.8 Construction Traffic

Quality	*Significance*	*Duration*
Negative	Slight	Temporary

13.6.2 Operational Phase

13.6.2.1 Wind Turbine Operation

The predicted noise levels associated with the proposed development will be within best practice noise criteria curves recommended in line with Irish guidance ‘Wind Energy Development Guidelines for Planning Authorities’, it is not considered that a significant effect is associated with the development.

While noise levels at low wind speeds will increase due to the development and specifically the operation of the turbines, the predicted levels will remain low, albeit new sources of noise will be introduced into the soundscape.

The predicted residual operational turbine noise effects are summarised as follows at the closest NSLs to the site:

Quality	*Significance*	*Duration*
Negative	Slight	Long-term

The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

For most of the locations assessed here the effect of the operational turbines are as follows:

Quality	*Significance*	*Duration*
Negative	Not significant	Long-term

The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

13.6.2.2 Substation Operation

In relation to the proposed substation location noise is expected to be inaudible at the nearest NSL, the associated effect at the closest NSLs is summarised as follows:

Quality	*Significance*	*Duration*
Negative	Imperceptible	Long-term

13.6.3 Vibration

There are no expected sources of vibration associated with the operational phase of the proposed development. In relation to vibration the associated effect is summarised as follows:

Quality	*Significance*	*Duration*
Negative	Imperceptible	Long-term

13.6.4 Cumulative Effects

This assessment has considered the potential cumulative impacts of the proposed development in combination with other wind energy developments in the area as required by best practice guidance discussed in Section 13.2.2.

All existing permitted and proposed wind farm developments with the potential for cumulative impacts have been included in the turbine noise impact assessment.

The proposed development of a Hydrogen Production Plant (Mayo County Council Planning Ref. 22/502) has the potential for cumulative impacts with the Proposed Development due to its proximity to the NSLs with in the study area. Refer to Chapter 3 for further details in relation to this development.

Reference has been made to the associated EIAR for the proposed hydrogen production plant ref. *Mayo Green Hydrogen Production Plant Environmental Impact Assessment Report (EIAR) Volume ii – EIAR Main Report* June 2022.

The EIAR present the predicted noise level for proposed hydrogen production plant at the nearest NSL. The nearest NSL identified are R71 (referenced as R03 in EIAR), R72 (referenced as R02 in EIAR) and R73 (referenced as R03 in EIAR).

Table 13-25 presents are review of the potential cumulative impacts of the proposed development at the nearest NSL to the proposed hydrogen production plant. It should be noted that the turbine noise levels are variable depending on wind speed, furthermore it is important to note the applicable noise criteria for wind turbine noise and that proposed for developments such as the proposed hydrogen production plant are different and not directly comparable.

Table 13-25 Cumulative review of Proposed Hydrogen Production Plant

Location Ref.	Predicted Noise level dB(A)				Change in Noise Level due to Proposed Development, dB
	Proposed Hydrogen Plant	Permitted Wind Turbines at Maximum Noise Output	Proposed Development at Maximum Noise Output	Cumulative Noise Level	
R71	14	40	27	40	0
R72	16	41	29	41	0
R73	27	42	29	42	0

The review has confirmed that there are no increases to the overall noise levels associated with the cumulative impacts at the nearest noise sensitive locations. It is concluded that the associated cumulative impacts the Proposed Development with the proposed hydrogen production plant are 'Not Significant'

Description of Effects

There are no significant cumulative impacts predicted with the operation of the Proposed Development. With respect to the EPA's criteria for description of effects, the potential effects at the nearest noise sensitive locations associated with the cumulative impact of the operation of the Proposed Development and the proposed hydrogen production plant are described below.

Quality	*Significance*	*Duration*
Negative	Not Significant	Long-Term

The above effects should be considered in terms that the effect is variable, and that this assessment considers the conditions of the greatest potential impact.

Bord na Móna made an application to An Bord Pleanála for leave to apply for Substitute Consent in respect of the historical peat extraction on the Oweninny Bog, which ceased in 2003 and this application is expected to be submitted in 2023. Rehabilitation works required under the IPC licence to address the historic extraction activity were completed in 2007 and therefore there is no potential for cumulative impacts in respect of the subject matter of that application for substitute consent and the Proposed Development.

13.7 SUMMARY

When considering a development of this nature, the potential noise and vibration effects on the surroundings must be considered for two stages: the short-term construction phase and the long-term operational phase.

The assessment of construction noise and vibration and has been conducted in accordance best practice guidance contained in BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise and BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Vibration. Considering the distance between the majority of construction activities and the nearest noise sensitive locations, noise associated with the construction phase is not expected to exceed the recommended threshold values. The associated noise and vibration are not expected to cause any significant effects.

Based on detailed information on the site layout, turbine noise emission levels and turbine hub height, worst-case turbine noise levels have been predicted at NSLs for a range of operational wind speeds. The predicted noise levels associated with the Proposed Development will be within best practice noise limits recommended in Irish guidance, therefore it is not considered that a significant effect is associated with the development.

Noise from the proposed substation has also been assessed and found to be within the adopted criteria.

No significant vibration effects are associated with the operation of the site.

13.8 REFERENCES

- EPA Guidelines on the Information to be contained in Environmental Impact Assessment Reports May 2022 (EPA, 2022)
- Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) document Guidelines for the Treatment of Noise and Vibration in National Road Schemes (NRA, 2004)
- BS 7385 – Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration (BSI, 1993).
- United Kingdom Highways Agency (UKHA) Design Manual for Roads and Bridges (DMRB) Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2 (UKHA 2020)
- ISO 9613: Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation, (ISO, 1996). Reference No. 1
- Institute of Acoustics: A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (2013)
- Wind Energy Development Guidelines" published by the Department of the Environment, Heritage and Local Government 2006
- Department of Trade & Industry (UK) Energy Technology Support Unit (ETSU) "The Assessment and Rating of Noise from Wind Farms" (1996).
- BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise
- BS 5228: 2014 & A1 2014 – Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration.
- ISO 1996: 2017: Acoustics — Description, measurement, and assessment of environmental noise.